The Great Basin Naturalist

VOLUME XXIX, 1969

EDITOR: VASCO M. TANNER
ASSOCIATE EDITOR: STEPHEN L. WOOD

PUBLISHED AT BRIGHAM YOUNG UNIVERSITY, BY
BRIGHAM YOUNG UNIVERSITY

VOLUME XXIX December 31, 1969 Nos. 1-4

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The
Great Basin
NATURALIST

Published by
Brigham Young University

GREAT BASIN NATURALIST

The Great Basin Naturalist
Published at Provo, Utah by
Brigham Young University

Volume XXIX March 28, 1969 No. 1

UNDESCRIBED SPECIES OF NEARCTIC TIPULIDAE (DIPTERA), X

Charles P. Alexander[1]

At this time I am describing various new species of crane flies from western North America, including Alaska and British Columbia, collected by Dr. Marion E. Smith and David L. Carson; Nevada by Dr. Donald G. Denning; and Utah, by Dr. George W. Knowlton. Dr. C. Dennis Hynes, and Dr. Donald W. Davis. I am greatly indebted to the persons listed for permission to retain the types of the novelties in my personal collection of World Tipulidae.

Genus Tipula Linnaeus

Subgenus Arctotipula Alexander

Tipula (*Arctotipula*) Alexander; Philippine Jour. Sci., 52:410; 1933.

Several species of *Arctotipula* now are known from Alaska and adjoining territories and a brief discussion of certain of the previously described forms seems to be advisable. The references cited are listed at the conclusion of the paper.

Lackschewitz (1936:290) has placed *Tipula* (*Arctotipula*) *aleutica* Alexander (1923) in the synonymy of *T.* (*A.*) *besselsi* Osten Sacken, certainly in error. The outer wing veins of *aleutica* have abundant macrotrichia while the hypopygial structure is quite distinct from that of *besselsi* and certain other allied species. In the same paper, Lackschewitz (1936:288) places *T.*(*A*) *alascaensis* Alexander (1923), described from the Pribilof islands, in the synonymy of *ciliata* Lundström (1915), a course that was followed by Savchenko (1961:325). It may be affirmed that the two flies are quite distinct in hypopygial characters, very definitely in the structure of the inner dististyle. In *alascaensis* the beak of the latter is short and obtusely rounded to appear almost suboval in outline, extending only a short distance beyond the very stout outer spine of the style. *T.* (*A.*) *øklandi* Alexander (1921), described from Nova Zembla, likewise was considered by both Lackschewitz and Savchenko as being identical with *ciliata* but paratype specimens in my

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[1] Amherst, Massachusetts.

collection have the conformation of the inner dististyle different from that shown by Savchenko (1961:326, fig. 3) for *ciliata*, including the beak and the outer spine.

Tipula (*Arctotipula*) *denali*, n.sp.

Size medium (wing of male 14.5 mm.); flagellar verticils short; general coloration of body dark gray, vestiture very reduced to nearly absent; wings yellowish white, restrictedly patterned with brown; *Rs* long, about two and one-half times *m-cu;* male hypopygium with posterior border of tergite triemarginate, the intermediate lobes acute, their mesal borders microscopically toothed; outer dististyle small, vestiture short.

MALE.— Length about 16 mm.; wing 14.5 mm.; antenna about 4 mm.

Frontal prolongation of head about three-fourths the remainder, light gray above, more plumbeous on sides, nasus stout; vestiture reduced to very sparse short stout black setae on outer half of prolongation; palpi black. Antennae black; flagellar segments without basal enlargements, longer than the verticils, beyond the first with dense short yellow setulae. Head uniformly gray with a vague more darkened line on posterior vertex; vertical tubercle low, depressed medially; posterior half of head with sparse short black setae, longer and porrect on genae and beneath, very reduced in number and size on vertex, lacking on the midportion.

Cervical region and pronotum blackened, heavily gray pruinose. Mesonotal praescutum light gray with four scarcely indicated darker gray stripes that are very narrowly bordered by darker; scutum gray, each lobe with two confluent darker areas, the anterior one smaller; posterior sclerites of notum light gray, parascutella pale; notum virtually glabrous, praescutal interspaces with microscopic punctures that bear tiny yellow setulae. Pleura light gray, vaguely patterned with darker gray areas; dorsopleural region buffy yellow. Halteres brown. Legs with coxae light gray, vestiture reduced to sparse microscopic yellow setulae; trochanters dark gray; femora and tibiae reddish brown, tips darker; tarsi dark brown; claws of male with a single slender tooth. Wings yellowish white, with an extensive pale brown clouded pattern that is subequal in extent to the ground, stigma darker brown, oval; more extensive brown clouds include a continuous seam along *Rs*, two large areas in cell *M*, most cells beyond cord, and outer ends of cubital and anal cells; the major ground areas include the prearcular and costal fields, cell *R* and inter-spaces of cells *M* and *Cu*, and the broad central part of cell *1st A*; outer radial field chiefly of the ground, including cell Sc_2, most of R_2, and a subbasal brightening in cell R_3; veins brown, obliterative sections very extensive, especially in the veins that enclose cell *1st* M_2. Veins posterior to *R* glabrous. Venation: *Rs* very long, about two and one-half times *m-cu*; petiole of cell M_1 shorter than *m*.

Abdomen dark plumbeous gray, basal tergite paler gray; posterior borders of both tergites and sternites very narrowly obscure yellow. Male hypopygium with tergite relatively narrow, transverse, posterior border with three U-shaped emarginations to produce two narrow acute intermediate lobes and broader lateral ones, the mesal borders of the intermediate pair microscopically toothed, of the lateral pair with a pale plate; vestiture of tergite relatively abundant but very short and inconspicuous. Ninth sternite with lobes elongate-oval, with long yellow setae. Basistyle oval, entire. Outer dististyle small, long-oval, with weak delicate setae; inner style with beak flattened, pale, tip obtuse; lower beak blackened, obtuse, posterior crest conspicuous, with darkened parallel lines at base; region of outer basal lobe a small plate that narrows into an acute black spine. Aedeagus long and very stout. Eighth sternite transverse, posterior border convexly rounded, medially with a triangular membranous area; setae very small and sparse, with a group of longer and more conspicuous yellow setae adjoining the membranous area.

HABITAT.— Alaska.

HOLOTYPE, Muldrow Glacier, McKinley National Park, July 19, 1952 (D. L. Carson).

The specific name '*denali*' is that of the native name for Mount McKinley, Denali, 'Home of the Sun'. I am referring this fly to the subgenus *Arctotipula* despite the differences in hypopygial structure from the subgenotype and allied species. The virtually glabrous body similarly is discordant in this subgenus. The wing pattern is approached by that of *Tipula* (*Arctotipula*) *twogwoteeana* Alexander of the higher Rocky Mountains of Colorado and Wyoming which has the hypopygial structure quite different, being more suggestive of species in the subgenus *Sinotipula* Alexander.

Tipula (*Arctotipula*) *epios*, n.sp.

Allied to *thulensis*, differing chiefly in hypopygial characters, especially the acutely pointed lobes of the ninth tergite and the broad outer dististyle.

MALE.— Length about 14 mm.; wing 15 mm.; antenna about 4 mm.

Frontal prolongation of head relatively short, about one-half the remainder, light gray; dorsal surface with long black setae, nasus long and stout; palpi black. Antenna black throughout; flagellar segment subequal to their longest verticils, basal enlargements poorly to scarcely developed. Head gray, front and orbits light gray; vertex with abundant long erect black setae, lacking on midarea; eyes relatively small, anterior vertex correspondingly broad.

Pronotal scutum gray, with long erect setae, scutellum brownish gray, the angles more reddened. Mesonotal praescutum light gray with four darker gray stripes, the intermediate pair narrowly separated by a central ground stripe without setae, remainder of ground areas with abundant long erect setae; scutum light gray, each lobe with two separate darker gray areas, vestiture short and very sparse; scutellum dark gray with very long setae, parascutella glabrous; postnotum uniformly gray, mediotergite with very long setae, pleurotergite glabrous. Pleura gray, doropleural region buffy yellow; sternopleurite and metapleura with long setae, lacking on meron. Halteres with stem brownish yellow, knob clearer yellow, base weakly darkened. Legs with coxae gray, setae very long; trochanters blackened, gray pruinose; femora brownish yellow, tips blackened; tibiae yellowish brown, darker outwardly; tarsi black; claw of male with a small triangular tooth at near midlength. Wings subhyaline to weakly tinted, cell *Sc* more yellowed; stigma oval, brown; veins light brown. Veins posterior to *R* chiefly glabrous, with trichia on R_{2+3}, distal section of R_{4+5} and restrictedly near outer end of *2nd A*. Venation: Petiole of cell M_1 shorter than *m*; M_{3+4} short, about one-half the basal section of M_{1+2} or less.

Abdomen dark plumbeous gray, extreme borders of the segments yellowed; hypopygium blackened. Male hypopygium with tergal lobes acute, tips pointed; median emargination broadly U-shaped, its diameter subequal to that of the lateral lobe. Outer diststyle very broad, the greatest width about three-fourths the length; inner style with lateral spine blackened, slender, gently curved.

HABITAT.— British Columbia.

HOLOTYPE, ♂, Alaska Highway, Mile 316, along 107 Creek, June 26, 1952 (M. E. Smith).

Among the numerous members of the subgenus the present fly is closest to *Tipula* (*Arctotipula*) *thulensis* Alexander, still known only from Baffin Island, Canadian Northwest Territories. It differs especially in details of hypopygial structure, as described. None of the northern Palaearctic members of the subgenus has the tergal lobes acute as in the present fly.

Tipula (*Arctotipula*) *mckinleyana*, n.sp.

General coloration of head and thorax gray, praescutum with four poorly differentiated darker gray stripes; antenna of male relatively short; wings faintly darkened, the long-oval stigma solidly darkened; male hypopygium with beak of inner diststyle relatively slender, on side before apex with a low blackened flange, margin at base of beak with a powerful broad-based lobe that narrows into a strong black spine, margin of style with one or two more basal spinous points.

MALE.— Length about 14 mm.; wing 15.5 mm.; antenna about 3.3 mm.

Frontal prolongation of head gray above, more brownish black beneath; nasus long and stout, with long black setae; palpi brownish black. Antennae relatively short; scape dark brown, sparsely pruinose, pedicel brown; flagellum black, segments without basal enlargements, slightly exceeding their longest verticils. Head with front and the broad orbits clear light gray, posterior vertex darker gray, with numerous relatively short black setae, midregion glabrous, light brown; ventral surface of head with very long pale setae.

Pronotal scutum dark gray, scutellum yellowed. Mesonotal praescutum light gray with four poorly differentiated darker gray stripes;

vestiture of interspaces long, erect; scutum almost uniformly dark gray, vestiture restricted to sparse long setae on the posterior callosities; scutellum brownish gray, with long setae, parascutella paler gray; mediotergite gray, with sparse long setae, pleurotergite gray. Pleura gray, glabrous; dorsopleural membrane buffy yellow. Halteres with stem pale brown, yellowed at base, knob darker, apex obscure yellow. Legs with coxae gray, with long pale setae; trochanters dark gray; femora yellow, tips conspicuously blackened; tibiae obscure yellow, darker outwardly; tarsi dark, claws of male toothed. Wings faintly darkened, stigma long-oval, dark brown; veins brown, those in costal and prearcular fields light brown. Veins posterior to *R* essentially glabrous, with three or four trichia on distal section of R_{4+5} and still more sparsely on *2nd A*. Venation: *Rs* about two and one-half times *m-cu*; cell *1st* M_2 long, nearly parallel-sided.

Abdomen dark brownish gray, posterior borders of tergites obscure yellow, of the sternites more narrowly so; hypopygium brownish black, tergal lobes and styli paler. Male hypopygium with tergite longer than broad, posterior third with two broad lobes that are separated by a very narrow emargination, inner edges of lobes and outer half of tergite with abundant black setae. Outer dististyle broadest at near midlength, the greatest width at near two-thirds the length; inner style with beak relatively slender, with a small blackened lateral flange beyond midlength; posterior margin of style with one or two basal spines and an outer very powerful broad-based lobe that bears the sensory area at its base, thence narrowed into a strong blackened spine that is directed outwardly. Eighth sternite transverse, posterior border nearly truncate, narrowly membranous, outer half of plate with numerous moderately long setae.

HABITAT.— Alaska.

HOLOTYPE. Sable Pass, McKinley National Park, July 20, 1952 (M. E. Smith).

Tipula (*Arctotipula*) *mckinleyana* differs from other generally similar species chiefly in details of structure of the male hypopygium, particularly the tergite and inner dististyle. The most similar species is *T.* (*A*) *smithiae* Alexander which differs in the wing coloration and in the hypopygium, especially the quite different inner dististyle.

Tipula (*Platytipula*) *knowltoniana*, n.sp.

Size small (wing about 10.5 mm.); mesonotal praescutum brownish gray with four darker brown stripes, pleura light gray; wings tinged with brown, costal border darker brown; abdominal segments with a darkened longitudinal central line; male hypopygium with tergal lobes appearing as broad circular blades that are bordered by black, at base of each on lower surface with a slender blackened rod; inner style with beak stout, disk with a conspicuous blackened bilobed structure.

MALE.— Length about 13 mm.; wing 10.5 mm.

FEMALE.— Length about 14 mm.; wing 10.5 mm.

Frontal prolongation of head light gray above, brownish yellow laterally; palpi brownish black. Antennae with scape and pedicel brownish yellow; flagellum broken. Head gray, orbits and sides of vertical tubercle more yellowed; a vague central darkening from summit of tubercle caudad almost to occiput.

Cervical region yellow. Pronotal scutum restrictedly yellowed, with three extensive gray areas, scutellum yellowed medially, sides gray. Mesonotal praescutum brownish gray with four darker brown stripes, the intermediate pair confluent at anterior ends, divided at near midlength, not reaching the suture behind; posterior sclerites of notum gray, each scutal lobe with a darkened spot laterally behind the suture, parascutella more yellowed. Pleura light gray, dorsopleural membrane yellow. Halteres with stem light brown, knob dark brown. Legs with coxae light gray; trochanters yellowed; femora brown, more yellowed basally, tibiae brown, tarsi passing into brownish black; claws of male small, simple; vestiture of legs of female long and erect, much as in *perhirtipes*. Wings tinged with brown, cells *C* and *Sc* conspicuously darker brown; stigmal region chiefly obscure yellow, with a more darkened cloud at either end, proximally including Sc_2, distally involving R_1 and free tip of Sc_2; veins brown. Sparse macrotrichia on veins R_3, R_{4+5}, M_1 and M_2 in male, in female more sparse and restricted to outer ends of veins R_3 *to* M_1. Venation: *Rs* and R_{2+3} subequal; petiole of cell M_1 from about one-third to one-half the length of the cell.

Abdominal tergites yellowish brown, sternites paler, both with a narrow central dark brown longitudinal stripe that becomes obsolete at about the seventh segment. Male hypopygium with tergal lobes appearing as broad circular pale brown blades with narrowly blackened margins, the intervening emargination subrectangular; each lobe at base of lower margin with a slender blackened rod. Outer dististyle relatively small, about three times as long as broad, tip obtuse; inner style with beak stout, on disk of style with a conspicuous blackened structure, its outer part unequally bilobed.

HABITAT.— Utah.

HOLOTYPE, ♂, Farmington, Davis Co., September 23, 1967 (G. F. Knowlton). ALLOTOPOTYPE, ♀, pinned with type.

I take great pleasure in naming this fly for my longtime friend and colleague, Dr. George F. Knowlton, to whom much of our present knowledge of the crane flies of Utah is due.

The fly is generally similar to the economically important Smoky Crane fly, *Tipula* (*Platytipula*) *cunctans* Say, differing evidently in hypopygial structure. A few further American members of the subgenus bear a resemblance to these, the one most similar to the present fly being *T.* (*P.*) *perhirtipes* Alexander which still is known only from the female type taken in Kennebec County, Maine, differing in its larger size and in slight details of coloration, wing venation and trichiation of the wing veins. It is believed that the discovery of the male sex of the eastern species will provide further characters for the separation of the two flies.

Tipula (*Sinotipula*) *denningi*, n.sp.

Belongs to the *commiscibilis* group, allied to *josephus*, differing evidently in hypopygial structure, especially the tergite and dististyles.

MALE.— Length about 20-21 mm.; wing 19-20 mm.; antenna about 3.0-3.5 mm.

FEMALE.— Length about 18 mm.; wing 22 mm.

Frontal prolongation of head dark brown, base yellowed; nasus long and slender; palpi brown. Antennae with scape and pedicel yellow, flagellum black; flagellar segments shorter than their verticils. Head light grayish brown, orbits and lateral parts of anterior vertex slightly more yellowed; vertex with a narrow dark brown median vitta.

Pronotal scutum light gray, with three brown areas; scutellum and pretergites light yellow. Mesonotal praescutum brownish yellow with four gray stripes that are narrowly margined with black, lateral borders broadly blackened; each scutal lobe with two darkened areas, the major inner one oval, gray, bordered with darker, central area obscure yellow; scutellum light brown with a narrow central darkened line, parascutella pearly yellow; mediotergite gray with a darkened central area, pleurotergite obscure yellow, patterned with brown. Pleura obscure yellow, mesepisternum variegated with gray; dorsopleural membrane light yellow. Halteres with stem yellow, base of knob brown, apex broadly light yellow. Legs with coxae yellow, patterned with brown; trochanters yellow; femora and tibiae obscure yellow, tips blackened; tarsi light brown; claws of male small, simple, nearly straight. Wings brownish gray, very inconspicuously patterned with pale brown and yellow; costal field yellowed; stigma oval, brown; disk with pale brown and yellow markings, the latter near outer end of cell *M* adjoining vein *cu*, and in cell *Cu* at either end of a darkened area at near one-third the length of cell; beyond cord, with conspicuous pale yellow seams along veins and marginally at centers of cells; veins brown. Costal fringe short and dense; trichia of veins *Sc* and *R* abundant, R_{4+5} with numerous trichia on more than outer half. Venation: *Rs* about one-third longer than R_{2+3}.

Abdominal tergites obscure orange yellow with a broad brown central stripe and narrow darker brown sublateral lines, extensively interrupted at bases and apices of segments, lateral borders narrowly yellow; sternites yellowish brown, posterior margins of intermediate segments yellow, narrower on outer sternites. Male hypopygium with lateral tergal arms unequally bilobed, with dense black setae, median area pale. Dististyles very unequal, outer style very large, conspicuously bilobed, provided with long black setae, upper arm narrower, terminating in a microscopic black point, near base with two blackened lobes, one glabrous, the other with abundant black setae; inner style much smaller, body with long black setae, rostrum long and slender. Phallosome a strong blackened horn, with a smaller basal point. Eighth sternite with posterior border truncate, unmodified.

Habitat.— Nevada.

Holotype, ♂, South Fork of Humboldt River, Elko County, August 27, 1967 (D. G. Denning). Allotopotype, ♀, with type. Paratopotypes, 2 ♂♂.

This interesting crane fly is dedicated to the collector, Dr. Donald G. Denning, outstanding student of the North American Trichoptera. The nearest relative is *Tipula* (*Sinotipula*) *josephus* Alexander, of eastern Oregon, readily distinguished by the structure of the hypopygium, particularly the tergite and dististyles. *T.* (*S.*) *commiscibilis* Doane is more distantly allied.

Tipula (*Eremotipula*) *eurystyla*, n.sp.

Size medium (wing of male 14 mm.); general coloration of thorax light gray, praescutum with narrow intermediate pale brown stripes; antennal flagellum black, segments incised; wings pale brownish gray, prearcular and costal fields yellowed, stigma light brown, veins brownish black; male hypopygium with tergal canthi small, tips obtuse; outer dististyle very broad, especially outwardly, diameter at apex nearly equal to the length; posterior margin of eighth sternite with long yellow setae.

Male.— Length about 14.5 mm.; wing 14 mm.

Frontal prolongation of head stout, slightly exceeding the remainder; nasus virtually lacking, represented by a small tubercle that bears a few long setae; prolongation brown, gray pruinose above, polished beneath. Antennae with scape and pedicel light yellow, flagellum abruptly black, segments with basal enlargements well-developed to present an incised appearance. Front and anterior vertex yellow; posterior vertex more grayish yellow with indications of a capillary darker median line.

Prothorax light yellow, including the scutellum and dorsopleural membrane. Mesonotal praescutum light gray with intermediate pale brown stripes that are narrower than the broad ground interspaces, lateral stripes very pale; pseudosutural foveae reduced to small shallow pits; posterior sclerites gray, each scutal lobe with two pale brown areas, the anterior one very small; scutellum and mediotergite with a poorly indicated darkened median line, parascutella more yellowed. Pleura gray. Halteres with stem yellow, knob brown. Legs with coxae gray; trochanters yellow; femora obscure yellow, tips darker; tibiae yellowish brown, darker outwardly, tarsi passing into black; claws of male with a strong tooth. Wings pale brownish gray, prearcular field, together with cells *C* and *Sc* yellow, stigma light brown, cell Sc_1 above it more yellowed; outer ends of radial cells and extensive clouds in both anal cells very slightly darker than the ground; obliterative area at cord whitened, inconspicuous; veins brownish black, much paler in the brightened costal field. Vein *1st A* without trichia, *2nd A* with these numerous and well distributed, extending basad almost to the arculus. Venation:

Petiole of cell M_1 shorter than the oblique *m*; *m-cu* shortly before fork of M_{3+4}.

Basal abdominal tergites light brownish gray, remaining tergites obscure yellow, the more proximal ones with indications of three brownish gray stripes, outer segments more uniformly yellow; sternites yellow, with abundant small erect dark setae. Male hypopygium with subtergal process of tergite elongate, the slender outer half pale and more membranous; canthi small, outer part narrow, apex obtuse. Outer dististyle distinctive, very broad, widened outwardly, apex nearly truncate; the diameter across apex nearly equal to the length of the style; inner style with dorsal crest strongly rounded, blackened; beak obtuse, lower beak very stout; outer basal lobe suboval, in size and outline not greatly different from the outer style. Eighth sternite with caudal margin fringed with very long yellow setae, none conspicuously enlarged. In the unique type the sternite is damaged but appears to have posterior lateral lobes that bear unusually long setae, with a further development of long setae between these groups.

HABITAT.— Utah.

HOLOTYPE, ♂, Dixie State Park, Washington County, April 24, 1968 (G. F. Knowlton and D. W. Davis).

The most similar species appears to be *Tipula* (*Eremotipula*) *mitrata* Dietz, of New Mexico, which is known to me only from the original description. From this the species appears to differ in coloration and structure of the antennae, coloration of the wings, and in details of hypopygial structure. The outer dististyle of the hypopygium in the present fly shows the maximum breadth of any species in the subgenus.

Gonomyia (*Idiocera*) *persimplex*, n.sp.

In general appearance most as in *coloradica* and *gothicana*, especially in the unpatterned wings; male hypopygium with all three dististyles simple.

MALE.— Length about 6 mm.; wing 5 mm.

Described from alcoholic material. Rostrum and palpi brown. Antennae black, proximal half of scape brownish yellow; flagellar segments oval, the outer ones more elongate. Head dark brown, anterior vertex, sides of vertical tubercle and the genae yellowish gray.

Pronotal scutum yellow, patterned with dark brown, scutellum yellowed. Mesonotal praescutum dark brown, lateral borders and an isolated area in humeral region light yellow; scutal lobes dark brown; scutellum brown, posterior border yellow; parascutella, pleurotergite and lateral borders of mediotergite light yellow. Pleura dark brown, dorsopleural region and a broad longitudinal stripe whitened. Halteres with stem pale, knob weakly darkened. Legs with coxae yellowed, fore pair slightly more infuscated; trochanters yellow; femora light brown, slightly darker near tips; remainder of legs brown. Wings subhyaline, unpatterned except for the small pale brown stigma, prearcular and costal fields slightly more yellowed; veins pale brown. Longitudinal veins beyond cord with trichia except R_3, also occurring on *Rs*, extreme outer end of basal section of Cu_1 and the distal third of *1st A*. Venation: Veins R_{1+2} and R_3 contiguous at margin; *m-cu* more than its own length before fork of *M*.

Abdomen dark brown, pleural membrane yellowed. Male hypopygium with outer lobe of basistyle broadly obtuse, with abundant long setae. All three dististyles simple; outer style longest, appearing as a slender pale spine that narrows to the long terminal point; intermediate style blackened on outer part, similar in shape to the outer style but shorter; inner style very pale, widened basally, outer end slender, blackened. Aedeagus of unique type broken. The intermediate styles of the two sides are unequal, one being only about one-half the size of the other, this presumably representing an abnormal condition.

HABITAT.— Utah.

HOLOTYPE, alcoholic ♂, Fish Creek, Sevier County, June 21, 1967 (C. D. Hynes).

The most similar regional species include *Gonomyia* (*Idiocera*) *coloradica* Alexander and *G.* (*I.*) *gothicana* Alexander, both quite different in hypopygial structure, especially the dististyles, as described.

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THE BUPRESTIDAE AND CLERIDAE OF THE NEVADA TEST SITE (COLEOPTERA)[1]

William F. Barr[2]

The collecting phases of the comprehensive ecological investigations conducted under the auspices of Brigham Young University at the Nevada Test Site in southern Nye County, Nevada, as reported by Allred, Beck and Jorgensen (1963a) yielded relatively few specimens of the beetle families Buprestidae and Cleridae. This is somewhat surprising inasmuch as these groups are usually considered to be major components of the Coleopterous fauna occurring in the desert and adjacent mountainous areas of the southwestern United States. However, several of the collections that were made do provide new or otherwise significant distributional or bionomical information for some of the species encountered. Therefore, a preliminary listing of the species of these two families taken at the Test Site along with a presentation of the available collection information seems warranted at this time.

For the exact location of collection sites and areas as listed herein, reference must be made to the papers by Allred, Beck and Jorgensen (1963b) and Knight (1968).

Appreciation is expressed to Drs. D. M. Allred and the late D. E. Beck of Brigham Young University for allowing me the opportunity of studying their material. This material was collected under Contracts AT(11-1)786 and AT(11-1)1326 between the Atomic Energy Commission and Brigham Young University.

Buprestidae

Hippomelas (*Gyascutus*) near *obliterata* LeConte

Specific determination of the 14 specimens taken at the Test Site is not possible at this time. Perhaps they represent one of the several species described by Casey (1909) from southwestern Utah which have been relegated to synonymy in the most recent catalogs. Unfortunately, Casey's descriptions are not sufficient in their characterization of important features to allow identification of the Test Site material and I have not had opportunity to make comparisons with his type material.

The Test Site collections were made between July 2 and August 2 in 1960, 1961, and 1962, at 9 and 9.5 miles N of Well 3B in a *Coleogyne* habitat, in the environs of Well 3B in a *Grayia-Lycium*

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[1] Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 780.

[2] University of Idaho, Moscow.

community, at 10 miles NW of Mercury and in the environs of Well 5B in a *Larrea-Franseria* community.

Melanophila consputa LeConte

Three large specimens, ranging in length from 12 to 14 mm., were taken in the environs of Mercury on *Larrea divaricata* (DC.), at 10 miles NW of Mercury and at Ground Zero in a can pit-trap in a *Grayia-Lycium* community. Collection dates were July 8, 1960, and July 22, 1962, and 1965.

M. consputa is known to develop only in coniferous trees, consequently the occurrence of specimens in desert areas of the Test Site some distance from a coniferous habitat may seem unusual. However, these specimens probably were attracted to smoke or fumes that were present in the desert areas. Such materials are known to be highly attractive to *M. consputa* and related species.

Melanophila pini-edulis Burke

This uncommon species is known from the intermountain West and adjacent regions, but has not been reported specifically from Nevada. One specimen was collected in Area 18 on June 20, 1965, and was associated with *Pinus monophylla* Torrey and Fremont.

Anthaxia (*Haplanthaxia*) *deleta deleta* LeConte

One specimen of this common and wide-ranging subspecies was taken in Area 12 on June 11, 1965, from *Cowania stansburiana* Torrey in a Juniper-Pinyon community.

Chrysobothris cuprascens LeConte

Six specimens were collected at Rainier Mesa on June 15, 1964, from *Pinus monophylla* Torrey and Fremont and *Juniperus osteosperma* (Torrey). They are assigned to *C. cuprascens* rather than to the closely related *C. semisculpta* LeConte on the basis of host plant association and geographic distribution. According to Fisher (1942) these two species are doubtfully distinct.

Chrysobothris arizonica Chamberlin

A single specimen, tentatively assigned to this species, was collected along the Basalt Area road, 12 miles NW of Tippipah Spring in a *Grayia-Lycium* community on July 13, 1964, from *Baileya pleniradiata* Harvey and Gray. The finding of *C. arizonica* on this plant probably constitutes a visitation rather than a host record.

Chrysobothris platti Cazier

This species has not been recorded previously from Nevada. One female was collected in the environs of Tippipah Spring on July

23, 1965, from *Ephedra viridis* Coville which undoubtedly is a host of this beetle.

Acmaeodera lanata Horn

A single specimen of this well-known southwestern species was collected in Area 16 on June 11, 1965, from *Dalea polyadenia* Torrey. The larva of this species is known to bore in the roots and lower stems of *Ephedra* spp.

Acmaeodera purshiae Fisher

Five specimens of this attractive species were collected. Three were taken in the environs of Tippipah Spring on June 14, 1965, from *Fallugia paradoxa* (D. Don), one was found 10 miles NW of Mercury on June 20, 1965, on *Purshia glandulosa* Curran and one was taken in the Mid Valley Area on July 28, 1962, and was associated with *P. tridentata* (Pursh). This species has been recorded previously from several areas of California and Oregon and from the Reno area of Nevada. Its only known host plant is *P. tridentata.*

Acmaeodera diffusa Barr, n. sp.

(Fig. 1)

Acmaeodera variegata, auctorum

MALE.—Medium-sized, moderately robust, black; pronotum blackish-bronze with a small yellow spot at sides immediately behind middle; each elytron with four transverse irregular straw-colored spots extending from lateral margin to near suture, first spot in front of basal fourth, second spot in front of middle and anteriorly oblique on disk, third spot in front of apical fourth and anteriorly oblique on disk, fourth spot in front of apex, small and oblique; upper surface moderately clothed with rather long erect and suberect brown hairs; ventral surface and legs moderately clothed with suberect whitish hairs.

HEAD densely punctured, punctures small and deep; vertex without a median carina; front convex except upper portion obliquely flattened; clypeus with front margin broadly, subtriangularly emarginate; antenna shining, extending to about hind margin of prosternum, serrate from fifth segment, outer segments slightly wider than long.

PRONOTUM slightly less than twice as wide as long, irregularly convex with a shallow transverse depression behind front margin, a small transverse median depression in front of base, a very faintly indicated median longitudinal depression in front of middle and a broad shallow depression surrounding the conspicuous subbasal pits; sides arcuate, widest at about basal third; lateral margins very slightly reflexed, visible from above on anterior half; front margin very broadly and feebly triangularly lobed at middle; surface more coarsely and densely punctured than on head, becoming sub-reticulate towards sides.

Elytra subequal in width to pronotum; disk irregularly depressed and flattened except for slightly elevated area near sides at basal fourth and for the narrowly elevated suture on apical three-fourths; sides nearly vertical, when viewed from above, feebly narrowing at basal fourth, slightly expanded at middle, and gradually evenly narrowing to conjointly rounded apices; front angles rectangular when viewed from the side; lateral margins broadly bisinuate when viewed from the side, most deeply emarginate at basal fourth, coarsely serrate on apical half; surface deeply punctured, slightly roughened at extreme base, strial punctures about subequal to those on thorax becoming smaller apically, interstrial spaces flattened with inconspicuous tiny punctures, third interstrial space feebly elevated, ninth interstrial space elevated at extreme base.

Ventral surface.—Thorax coarsely, densely punctured; front margin of prosternum retracted, subtruncate, very slightly reflexed on either side of middle. Abdomen rather finely densely punctured except for first sternite which is more coarsely punctured at middle and along front margin; last sternite short and broad, feebly convex at middle and without a subapical plate or elevation, margins narrowly reflexed, lateral margin straight, oblique, hind margin very broadly rounded.

Length.—8.4 mm.; width, 2.9 mm.

Holotype, male (California Academy of Sciences) from Highland Range, above Mendha, Lincoln County, Nevada, July 9, 1965 (W. F. Barr). Two hundred and twenty-three paratypes from type locality July 9, 1965 (W. F. Barr and R. L. Westcott), and June 25, 1966 (E. J. Allen, W. F. Barr, D. S. Horning, Jr., R. L. Westcott and R. L. Penrose), most specimens collected from the flowers of *Opuntia* sp. and *Sphaeralcea* sp., others on the flowers of *Chaenactis* sp., *Garrea* sp. and *Calochortus* sp. One paratype from Nevada Test Site, Mercury, Nevada, June 11, 1965, on *Viguiera multiflora* (Nutt.) Blake. Ten paratypes from Pine Valley, Washington County, Utah, June 2, 1960 (Verity and Raven), and from the same locality, 31 paratypes, June 12 and 14, 1961 (D. W. Davis and B. Haws), one paratype June 25, 1948, and one paratype June 27, 1933 (J. T. Howell). Paratypes in the collections of the American Museum of Natural History, California Academy of Sciences, Los Angeles County Museum, U. S. National Museum, Brigham Young University, University of Idaho, Utah State University; W. F. Barr, F. M. Beer, D. S. Horning, Jr., J. N. Knull, G. H. Nelson, R. L. Penrose, D. S. Verity, and R. L. Westcott.

Many additional specimens have been examined which have not been designated as paratypes. Distributional information from these specimens is as follows: Arizona: Betatakin Cyn.; Navajo National Monument; Grand Canyon; Jacob Lake; Kayenta, Navajo County; Navajo Mt., Navajo County; Prescott; and near Williams. Colo-

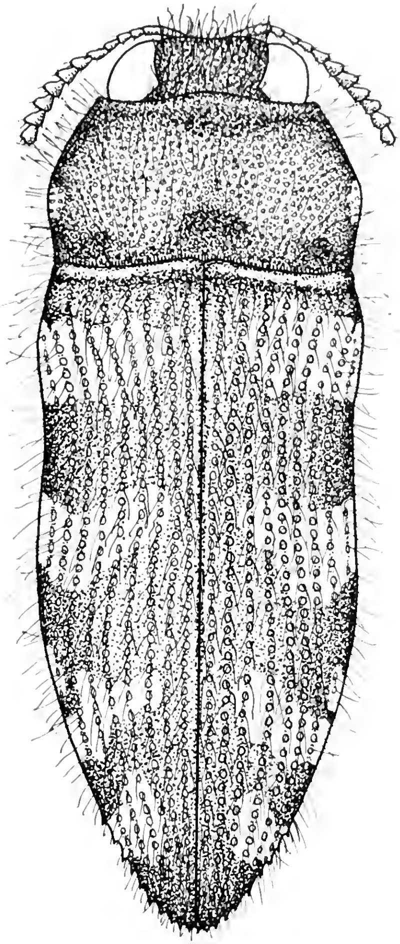

Fig. 1. *Acmaeodera diffusa*, new species, dorsal view of holotype.

RADO: Durango; Glenwood Springs; Meeker; and Mesa Verde. UTAH: American Fork Canyon; Aspen Grove, Timpanogos; Beaver Canyon; Beaver Cr., Kamas; Bryce Canyon; Cainville; City Cr. Canyon; Dugway; Emigration Canyon, Salt Lake County; Escalante; Farmington, Davis County; Fort Douglas; Fruita; Glendale, Hanksville; Indianola; Jordan River; Lehi; Little Cottonwood Canyon, Wasatch Mountains; Mount Dell Cr., Salt Lake City; Mt. Nebo, Juab County; Mt. Timpanogos; North Fork of Provo Canyon; Oak Creek Canyon; Ogden; Park City; Parley's Canyon; The Pass, Table Cliff Mountain, Garfield County; Payson Canyon, Utah County; Provo; Provo Canyon; Red Butte; Rock Canyon, Provo; St. George;

Salt Lake; Salt Lake City; Spanish Fork; Stockton; Vivian Park; Wasatch Mountains; Zion Lodge; Zion National Park.

A. diffusa is a well-known species that has a wide distribution range in the western United States. It is especially abundant in the Intermountain Regions. In most of the literature and in most collections it is referred to as *A. variegata* LeConte, but that name must be utilized for another distantly related species that occurs in New Mexico and Arizona.

This species may be separated from other known species by the lack of a subapical plate or elevation on the shortened and broadly rounded last abdominal sternite, by the irregularly flattened elytral disk and by the coarsely and densely, nearly cribrately punctured pronotum which usually is of a dark bronzy color. The yellowish elytral markings, consisting of three pairs of fasciae and a pair of subapical spots, although distinctive, are variable. These markings usually are irregular and interrupted at the suture, but may be broken, reduced or greatly expanded. The pronotal spots also are of a variable nature. They exhibit considerable difference in size, may be present on one side of the pronotum or may be entirely absent. In the case of the type series these spots are present on approximately 70 percent of the specimens.

Acmaeodera sp.

Four specimens belonging to the *retifer* species complex were taken in an *Artemisia* community 4.4 miles S of Tippipah Spring and at Tippipah Spring on June 13, 1964. They were found on *Argemone corymnosa* (Greene) and *Eriogonum fasciculatum* Benth.

The *retifer* complex is in need of a thorough taxonomic study before names can be assigned to its many populations that occur in the Pacific Coast and intermountain states.

Acmaeodera immaculata Horn

One specimen of this widespread Great Basin and Mohave Desert inhabitant was collected 4.4 miles S of Tippipah Spring in an *Artemisia* community. It was found on *Baileya pleniradiata* Harvey and Gray. In southern Idaho *A. immaculata* is known to develop only in the roots of *Eurotia lanata* (Pursh), but adults are frequently encountered on the flowers of a variety of plants including the Compositae.

Agrilus pubifrons Fisher

This species, previously known from southern Idaho and eastern Oregon, is recorded from Nevada for the first time. Four specimens were taken at the Test Site in Area 12 and in Area 18 on June 11, July 27 and August 7, 1965, on *Chrysothamnus visidiflorus* (Hook.), *C. parryi* (A. Gray) and *Grayia spinosa* (Hook.). *C. viscidiflorus* is its only known host plant. .

Agrilus felix Horn

One specimen, tentatively identified as this species by J. N. Knull, was collected at 4.5 miles SE of Well 5B on June 11, 1964, from *Sphaeralcea ambigua.*

Cleridae

Cymatodera uniformis Schaeffer

Collections of this species were made at Yucca Flat in a *Grayia-Lycium* community, at Rainier Mesa in a Juniper-Pinyon community and in Area 12 in a Juniper-Pinyon community. The five specimens collected on August 13 and 14, 1964, were attracted to incandescent and black light.

C. uniformis has been recorded previously from southern Arizona and southern California where it has been reared from *Juniperus* spp.

Cymatodera latefascia Schaffer

This distinctive species has not been known from Nevada. Two specimens were collected at Rainier Mesa on August 9, 1964, in an *Artemisia* community and in Area 18 on July 25, 1965. In both collections the specimens were attracted to incandescent light traps.

Cymatodera oblita Horn

Four specimens were found at Rainier Mesa in a Juniper-Pinyon community and in the Area 12 residence area. They were attracted to black light and incandescent light on August 8 and 11, 1964.

Cymatodera fuchsii Schaeffer

This was the most commonly encountered clerid species of the Test Site collections. Forty-seven specimens were collected at the following locations: 10 miles NW of Mercury; 9.3 miles W of Mercury; environs of Mercury; Area 5 in a *Grayia-Lycium* community; Well 5B; W of Frenchman Playa, in *Larrea* and *Lycium* communities; Yucca Flats, 5.5 miles NW of Well 3B, in a *Grayia-Lycium* community; and Jackass Flats, W of Cane Springs. Dates of the collections ranged from July 15 to August 24. The specimens, which were taken in can pit-traps, at blacklight and at incandescent light, are remarkedly uniform in the coloration of the elytra. All have the elytral fascia moderately distinct. The great majority are of a pale reddish-brown color, with few specimens showing a darker coloration, but none exhibit the usual tan color of specimens from other localities.

Phyllobaenus quadrimaculatus (Van Dyke)

A single female specimen was found at Cane Springs on June 13, 1965, on *Stanleya pinnata* (Pursh). This specimen appears to fit the original description of *P. quandrimaculatus* except that the dark portions of the elytra lack a greenish luster and the elytral markings are more extensive. In addition the legs of the Cane Springs specimens are yellowish except for the darkened apices of the mesofemora and the predominately darkened metafemora.

Phyllobaenus pygmaeus (Wolcott)

One specimen, tentatively assigned to this species, was collected W of Cane Springs on June 18, 1965, from *Artemisia* sp. Positive identification of many of the described species of North American *Phyllobaenus* is not possible because of the poor taxonomic state of the genus.

Phyllobaenus subfasciatus (LeConte)

A specimen collected W of Cane Springs on June 20, 1965, from *Atriplex canescens* (Pursh) falls within the currently recognized concept of this widespread and very variable species.

Trichodes ornatus Say

This well-known species was not commonly found at the Test Site. Only 13 specimens were taken, but two variants are represented in the series. Twelve of the specimens have reddish elytra with the black fasciae showing varying degrees of reduction, especially on the basal half. This variation is characteristic of populations occurring in the Great Basin and immediately adjacent areas. The other specimen represents one of the Sonoran Desert variations which has the elytra predominately yellow in color with narrow black fasciae.

Collections were made at Tippipah Spring, Area 17, Mercury, Yucca Flat and Mid-Valley on May 18, 1960, June 12-17, 1965, and July 21, 1962. The specimens were found probably on the flowers of *Sphaeralcea* sp., *Tetradymia glabrata* Gray, *Chrysothamnus* sp. and *Malacothrix glabrata* Gray.

Serriger reichei Spinola

This uncommon species was collected at Yucca Flat in a *Grayia-Lycium* community, at Cane Springs, W of Cane Springs and at Area 9. Seven specimens were taken between June 10 and 18, 1965, from *Sphaeralcea* sp., *Tetradymia glabrata* Gray, *Lepidium fremontii* S. Wats. and *Salazaria mexicana* Torrey. These collections constitute a new state record for Nevada. Previously, *S. reichei* has been known in the literature only from single localities in southeastern California and southwestern Idaho.

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BEES OF THE NEVADA TEST SITE[1]

Dorald M. Allred

During the years from 1959 to 1965, many bees were collected at the Nevada Test Site as part of the ecological studies conducted by the Department of Zoology and Entomology of Brigham Young University, under contract with the U. S. Atomic Energy Commission. Most of these were recently identified by Dr. G. E. Bohart, Entomology Research Division, Department of Agriculture, Logan, Utah, and Mr. P. H. Timberlake, Riverside, California. The identifications form the basis of this report on the host relationships, seasonal occurrence, and geographic distribution at the test site.

Further studies specifically directed toward the bees, particularly during the blooming periods of the desert plants, undoubtedly would yield additional records. Genera and species are listed alphabetically for convenience. Areas of collection refer to divisions delineated by Allred, Beck, and Jorgensen (1963a and b). Methods of collection used were hand capture, aerial and sweep nets, and can pit-traps (Allred *et al.*, 1963a).

SPECIES AND PLANT ASSOCIATIONS

Agapostemon cockerelli: 2♀♀; areas 17, 18; *Malacothrix glabrata*; June, July.

A. texana: 2♂♂ 3♀♀; areas 5, 12, CB, *Asclepias erosa*, *Petradoria pumila*, *Stanleya pinnata* (most common host); June, Aug.

Andrena sp.: ♂; area CE; host unknown; March.

Anthidium dammersi: ♂♀; areas 1, 18; *Erigeron pumilus;* May; June.

Anthophora californica: ♂ ♀; area 5; *Stanleya pinnata*; June.

A. porterae: ♂; area 4; host unknown; March.

A. urbana: 8♂♂ 24♀♀; areas 5, 12, 17, 18, CB, TM; *Asclepias erosa*, *Astragalus lentiginosus*, *Gayophytum ramosissima*, *Malacothrix glabrata*, *Oenothera californica*, *Petradoria pumila*, *Stanleya pinnata;* most common host was *S. pinnata*, with *A. erosa* and *P. pumila* also frequently represented; most were taken in June, about half as many in July, and few in August.

Anthophora new species: 5♂♂ 1♀; area CE; host unknown; March.

Ashmeadiella aridula: ♀; area 2; *Pectis papposa*; Aug.

A. australis: ♀♀ 2?; area 12, *Penstemon palmeri*; July.

A. bigeloviae: ♀; area 10; *Salsola kali*; Sept.

A. inyoensis: 4♂♂; area 5; host unknown; May.

A. opuntiae: 2♂♂ 3♀♀; areas 12, 13, CB; *Echinocereus engelmannii* (most common host), *Opuntia erinacea;* May, July.

Bombus morrisoni: 7♀♀; areas 5, 12; *Petradoria pumila* (most common host), *Stanleya pinnata*, *Viguiera multiflora;* July, Aug.

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[1] BYU-AEC publication no. COO-1355-19.

Centris rhodopus: 19♂♂ 6♀♀; areas 5, 6, CB, 401. *Cleome lutea*, *Eriogonum inflatum*, *Stanleya pinnata* (most common host), *Tamarix pentandra*; June-Sept., mostly July.

Ceratina nanula: ♀; area 17; *Malacothrix glabrata*; June.

Chelostomoides lobatifrons: ♂; area CB; *Asclepias erosa*; June.

Dialictus albohirtus: 33♂♂ 3♀♀; areas 5, 6, 12, CB, EM, T; *Artemisia tridentata*, *Asclepias erosa* (most common host), *Chrysothamnus paniculatus*, *Eriogonum inflatum*, *Eriogonum fasiculatum*, *Larrea divaricata*, *Petradoria pumila*, *Salix gooddingii*, *Stanleya pinnata*, *Tamarix pentandra*; June (mostly), July.

D. hyalinus: ♂ 11♀♀; areas 1, 5, 6, 12, 17, CB, EC; *Acamptopappus shockleyi*, *Asclepias erosa*, *Calochortus flexuosus*, *Malacothrix glabrata*, *Penstemon palmeri*, *Stanleya pinnata*, *Viguiera multiflora*; May-Aug.

D. incompletus: 12♀♀; areas 12, FM; *Bromus rubens*, *Calochortus flexuosus*, *Penstemon bridgesii*, *Penstemon floridus*, *Penstemon palmeri* (most common host); July.

D. microlepoides: 11♂♂ 7♀♀; areas 12, CB, EM; *Artemisia tridentata*, *Asclepias erosa* (most common host), *Eriogonum fasiculatum*, *Penstemon bridgesii*, *Tamarix pentandra*, *Viguiera multiflora*; June (mostly), July.

D. nevadensis: 2♀♀ area 12; *Penstemon palmeri*; July.

D. pruinosum: ♂; area CB; *Asclepias erosa*; June.

Dialictus sp. 1, ? new: 2♀♀; area 12; *Castilleja linariaefolia*, *Chrysothamnus* sp.; July, Aug.

Dialictus sp. 2, ? new: ♂; area CB; *Asclepias erosa*; June.

Dialictus sp. 3, ? new: ♀; area 410; *Eriogonum fasiculatum*; July.

Colletes eulophi: ♂♀; areas 5, 17; *Sphaeralcea* sp., *Stanleya pinnata*; June.

Colletes sp., ? new: ♀; area 17; *Sphaeralcea* sp.; June.

Diadasia australis: 2♂♂; areas 12, 17; *Opuntia erinacea*; June, July.

D. diminuta: 4♂♂ 3♀♀; areas 5, 17; *Sphaeralcea ambigua* (most common host), *Stanleya pinnata*; June.

D. lutzi: ♂♀ 1?; areas 5, 17; *Sphaeralcea* sp., *Stanleya pinnata*; June.

Dianthidium pudicum: ♂♀; areas 16, 19; *Chrysothamnus viscidiflorus*; June, Aug.

D. subparvum: ♂♀; area 12; *Chrysothamnus viscidiflorus*, *Petradoria pumila*; July, Aug.

D. ulkei: 2♂♂; areas 12, FC; *Artemisia tridentata*; July.

Dioxys productus: ♂; area 5; host unknown; March.

Dufourea new species 1: ♀; area JA; host unknown; April.

Dufourea new species 2: ♀♀; area 12; *Phacelia peirsoniana*; June.

Epeolus minimus: ♀; area 5; host unknown; May.

Evylaeus ruficornis: ♀; area 19; host unknown; June.

Halictus hyalinus: ♀; area 401; *Chrysothamnus parryi*; Aug.

H. tripartitus: 7♀♀; areas 12, CB, FM; *Calochortus flexuosus*, *Eriogonum fasiculatum*, *Lupinus palmeri*, *Penstemon* sp., *Petradoria pumila*, *Viguiera multiflora*; June, mostly July, Aug.

Heriades timberlakei: 5♂♂ 4♀♀; areas 12. 13; *Opuntia erinacea. Viguiera multiflora;* July.

Hesperapis wilmattae: ♀; area 401; *Malacothrix glabrata;* June.

Hylaeus asininus: 2♂♂; area 12; *Chrysothamnus viscidiflorus;* Aug.

Hypomacrotera subalpinus: 4♂♂; area 5; *Baileya multiradiata, Sphaeralcea ambigua, Stanleya pinnata;* June.

Lasioglossum sisymbrium: 3♀♀ 5?; areas 5, 12, 18. 19; *Chrysothamnus viscidiflorus, Erigeron pumilis. Hymenoxys cooperi, Penstemon* sp., *Stanleya pinnata, Viguiera multiflora;* June-Aug.

Lithurgus apicalis: 3♂♂ 1♀; areas 12. 13; *Opuntia erinacea;* July.

Melectamorpha californica: 2♂♂ 2♀♀; areas 5. CB; *Asclepias erosa, Stanleya pinnata;* June. July.

Melissodes subagilis: 7♀♀; areas 5. 12. 17; *Baileya multiradiata, Chrysothamnus viscidiflorus. Petradoria pumila, Sphaeralcea ambigua. Stanleya pinnata;* June-Aug.

M. tristis: ♀; area 12; *Petradoria pumila;* July.

Micranthophora hololeuca: 2♂♂ 2♀♀; area TA; *Sphaeralcea munroana;* June.

M. phenax: ♂; area 1; host unknown; April.

Nomia tetrazonata: ♂; area CE; *Berula erecta;* July.

Osmia titusi: ♂; area 5; host unknown; March.

Osmia sp., ? new: ♂ ♀; areas 5. 17; *Astragalus lentifinosus. Descurainia pinnata;* May. June.

Perdita arcuata: ♂ 2♀♀; area 5; *Sphaeralcea ambigua;* June.

P. callicerata: ♂; area 12; *Chrysothamnus paniculatus;* June.

P. chloris: ♀; area 16; *Eriogonum deflexum;* Aug.

P. fallugia: 5♂♂; areas 12. 18; *Cowania* sp. (most common host), *Erigeron pumilus, Oenothera californica;* June.

P. nasuta: 2♀♀ 7?; area 6; *Eriogonum inflatum;* July.

P. thermophila: ♂ ♀; areas 6. 410; *Eriogonum inflatum;* July.

Perdita new species: 8♀♀; areas 16. 401; *Dalea polyadenia, Eriogonum deflexum* (most common host); Aug.

Sphecodes eustictus: ♀; area 12; *Eriogonum deflexum*; Aug.

Stelis new species: ♀; area 10; host unknown; April.

Tetralonia quadricincta: ♂; area 4; host unknown; March.

Tetralonia new species "al": ♂ 2♀♀; areas 4, 5; *Stanleya pinnata;* March. June.

Tetralonia new species "an": ♂; area 4; host unknown; March.

Tetralonia new species "mo": ♀; area 4; host unknown; March.

Tetralonia new species "pr": 4♂♂ 32?; areas 4, 5; host unknown; March.

Triepeolus helianthi: ♂; area 5; *Sphaeralcea ambigua;* June.

Xylocopa californica: ♀ 7?; areas 5. M; *Stanleya pinnata;* June (mostly). July.

PLANT-BEE ASSOCIATIONS

Acamptopappus shockleyi
  Dialictus hyalinus
Artemisia tridentata
  Dialictus albohirtus
  D. microlepoides
  Dianthridium ulkei

- *Asclepias erosa*
  - *Agapostemon texana*
  - *Anthophora urbana*
  - *Chelostomoides lobatifrons*
  - *Dialictus albohirtus*
  - *D. hyalinus*
  - *D. microlepoides*
  - *D. pruinosum*
  - *Dialictus* sp. 2
  - *Melectamorpha californica*
- *Astragalus lentiginosus*
  - *Anthophora urbana*
  - *Osmia* sp.
- *Baileya multiradiata*
  - *Hypomacratera subalpinus*
  - *Melissodes subagilis*
- *Berula erecta*
  - *Nomia tetrazonata*
- *Bromus rubens*
  - *Dialictus incompletus*
- *Calochortus flexuosus*
  - *Dialictus hyalinus*
  - *D. incompletus*
  - *Halictus tripartitus*
- *Castilleja linariaefolia*
  - *Dialictus* sp. 1
- *Chrysothamnus paniculatus*
  - *Dialictus albohirtus*
  - *Perdita callicerata*
- *Chrysothamnus parryi*
  - *Halictus hyalinus*
- *Chrysothamnus viscidiflorus*
  - *Dianthidium pudicum*
  - *D. subparvum*
  - *Hylaeus asininus*
  - *Lasioglossum sisymbrium*
  - *Melissodes subagilis*
- *Chrysothamnus* sp.
  - *Dialictus* sp. 1
- *Cleome lutea*
  - *Centris rhodopus*
- *Cowania* sp.
  - *Perdita fallugia*
- *Dalea polyadenia*
  - *Perdita* sp.
- *Descurainia pinnata*
  - *Osmia* sp.
- *Echinocereus engelmanni*
  - *Ashmeadiella opuntiae*
- *Erigeron pumilis*
  - *Anthidium dammersi*
  - *Lasioglossum sisymbrium*
  - *Perdita fallugia*
- *Eriogonum deflexum*
  - *Perdita chloris*
  - *Perdita* sp.
  - *Sphecodes eustictus*
- *Eriogonum fasiculatum*
  - *Dialictus albohirtus*
  - *D. microlepoides*
  - *Dialictus* sp. 3
  - *Halictus tripartitus*
- *Eriogonum inflatum*
  - *Centris rhodopus*
  - *Dialictus albohirtus*
  - *Perdita nasuta*
  - *P. thermophila*
- *Gayophytum ramosissima*
  - *Anthophora urbana*
- *Hymenoxys cooperi*
  - *Lasioglossum sisymbrium*
- *Larrea divaricata*
  - *Dialictus albohirtus*
- *Lupinus palmeri*
  - *Halictus tripartitus*
- *Malacothrix glabrata*
  - *Agapostemon cockerelli*
  - *Anthophora urbana*
  - *Ceratina nanula*
  - *Dialictus hyalinus*
  - *Hesperapis wilmattae*
- *Oenothera californica*
  - *Anthophora urbana*
  - *Perdita fallugia*
- *Opuntia erinacea*
  - *Ashmeadiella opuntiae*
  - *Diadasia australis*
  - *Heriades timberlakei*
  - *Lithurgus apicalis*
- *Pectis papposa*
  - *Ashmeadiella aridula*
- *Penstemon bridgesii*
  - *Dialictus incompletus*
  - *D. microlepoides*
- *Pensteman floridus*
  - *Dialictus incompletus*
- *Penstemon palmeri*
  - *Ashmeadiella australis*
  - *Dialictus hyalinus*
  - *D. incompletus*
  - *D. nevadensis*
- *Penstemon* sp.
  - *Halictus tripartitus*
  - *Lasioglossum sisymbrium*
- *Petradoria pumila*
  - *Agapostemon texana*
  - *Anthophora urbana*
  - *Bombus morrisoni*
  - *Dialictus albohirtus*
  - *Dianthidium subparvum*
  - *Halictus tripartitus*
  - *Melissodes subagilis*
  - *M. tristis*
- *Phacelia peirsoniana*
  - *Dufourea* sp. 2
- *Salix gooddingii*
  - *Dialictus albohirtus*
- *Salsoli kali*
  - *Ashmeadiella bigeloviae*
- *Sphaeralcea ambigua*
  - *Diadasia diminuta*
  - *Hypomacrotera subalpinus*
  - *Melissodes subagilis*
  - *Perdita arcuata*

Triepeolus helianthi
Sphaeralcea munroana
  Micranthophora hololeuca
Sphaeralcea sp.
  Colletes eulophi
  Colletes sp.
  Diadasia lutzi
Stanleya pinnata
  Agapostemon texana
  Anthophora californica
  A. urbana
  Bombus morrisoni
  Centris rhodopus
  Dialictus albohirtus
  C. hyalinus
  Colletes eulophi
  Diadasia diminuta
  D. lutzi
  Hypomacrotera subalpinus
  Lasioglossum sisymbrium
  Melectamorpha californica
  Melissodes subagilis
  Tetralonia sp.
  Xylocopa californica
Tamarix pentandra
  Centris rhodopus
  Dialictus albohirtus
  D. microlepoides
Viguiera multiflora
  Bombus morrisoni
  Dialictus hyalinus
  D. microlepoides
  Halictus tripartitus
  Heriades timberlakei
  Lasioglossum sisymbrium

SUMMARY

Between 1959 and 1965, bees representing 71 species of 35 genera were collected from plants of more than 40 species at the Nevada Test Site. Bees of nine of the species are new to science, and six others possibly are new. Most specimens were taken during June and July, but some were found as early as March and others as late as September. Bees of greatest abundance, as indicated by those collected, were *Dialictus albohirtus*, *Tetralonia* n. sp. "pr," *Anthophora urbana*, and *Centris rhodopus*. Those with the widest geographic distribution at the test site were *Dialictus hyalinus*, *D. albohirtus*, and *Anthophora urbana*. The species found on the greatest variety of plants was *Dilictus albohirtus*. A greater variety of bees was found on *Stanleya pinnata*, *Asclepias erosa*, and *Petradoria pumila* than on other plants.

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A NOTE ON GERANIUM RICHARDSONII FISCH. & TRAUTV.

John W. Van Cott[1]

While examining specimens of the genus *Geranium* it became apparent that there were discrepancies between published botanical descriptions based on herbarium specimens and plants as they occur naturally. It is always difficult to collect a large specimen and to arrange it to fit a herbarium sheet. Often, the specimen is separated into individual stems, or portions are discarded before pressing. When such an alteration is necessary and when incomplete or altered specimens are placed in collections, they form the basis upon which descriptions are made. Such circumscriptions have led to confusion of students attempting to understand taxonomic entities.

Descriptions of *Geranium richardsonii* are cited as an example. In 1907, Hanks and Small (p. 18) described *G. richardsonii* as "caudex often slightly branched." Jones and Jones (1943, p. 32) described it with "the usually simple caudex" whereas Harrington (1954, p. 352) cited that species as "plants . . . erect from a simple caudex." These three statements are slightly misleading because the Richardson Geranium is often definitely rhizomatous (Figs. 2, 3, 4) even though a great many specimens appear to have only a simple caudex (see Fig. 1). Plants such as those appearing in Figures 2, 3, and 4, are often broken apart in such a manner as to appear like the specimen in Figure 1.

Shaw (1952, p. 302), who did extensive field work on *G. richardsonii*, described it more accurately as having the "caudex often branched."

It seems probable that the more misleading descriptions cited above might well have been derived from specimens which lack complete caudices. Of course, there are specimens in herbaria which do represent the situation as it occurs in nature, but there are a large number of inadequate specimens and it is these which prompt this note. Thus, after an examination of some three hundred herbarium sheets and numerous plants in the field, I present herein a description of the caudex of *G. richardsonii*.

Caudex clothed with scale-like, brownish, remnants of petioles and stipules, simple or branched; rhizomes, when present, 3-17 cm long, one to several from a central, stout, woody, perennial rootstock with a more or less prominent, simple or branched taproot.

Representative Specimens. arizona: Apache Co., White Mt. Scout Camp, *Deaver* 4660 (asc). Coconino Co., Weatherford Road, San Francisco Peaks, *Carson* 268 (asc); road to Weimer Springs, N of Mormon Mts., *Carson* 49 (asc); NW side of Mormon Mt., *Kynoch* 332 (bry). california: Alpine Co., head of East Carson River,

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Fig. 1. UTAH. Sanpete Co.: Head of Lake Fork, T19S, R4E, ca. 10,000′. *Van Cott* 943 (BRY).
Figs. 2, 4. UTAH. Garfield Co.: Escalante Canyon, 5 mi E of Widstoe, T34S, R1W, ca. 8,000′. *Van Cott* 981a and 981b (BRY).
Fig. 3. UTAH. Garfield Co.: 9 mi N of Boulder on Deer Creek, T32S, R5E, 7,500′. *Van Cott* 987 (BRY).

Johnson 213 (USU). COLORADO: Boulder Co., ¼ mi above Science Lodge, *Murdock* 542 (BRY). IDAHO: Bear Lake Co., Emigration Canyon Forest Camp, *Shaw* 69 (USU); Caribou Co. N of Pruess and Montpelier Creek Divide, S23, T11S, R45E, Caribou Natl For, *Major* 20 (USU). MONTANA: Beaverhead Co., U.S. Sheep Exp Station, Odell Creek, *Calvert* 102 (BRY). UTAH: Kane Co., left fork of headwater of Virgin River 15 mi NW of Orderville, *Maguire* 18823 (BRY); Summit Co., near Lost Lake, Uinta Mts., *Patrick* 150 (BRY); 3 mi west of Holiday Park, *Welsh et al.* 6305 (BRY); San Juan Co., shady places along Indian Creek 13 mi west of Monticello, *Conquist & Holmgren*, 9403 (USU).

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NEW COMBINATIONS AND A NEW SPECIES OF PERENNIAL CRYPTANTHA

Larry C. Higgins[1]

The preparation of a revision of the perennial *Cryptantha*, subgenus Oreocarya of North America, has led to the recognition of an undescribed species. and to adjustments in nomenclature. The conclusions presented here are the results of three years work with this group. Numerous field trips resulting in the collection of several thousand herbarium sheets has partially filled in some of the gaps in the distribution and understanding of this subgenus.

The writer wishes to express his thanks to the Society of Sigma Xi for their grant-in-aid of research. which made it possible to do the necessary field work for this paper.

1. *Cryptantha shackletteana* sp. nov.

A *C. spiculifera* (Piper) Payson. differt foliis longior et angustior, pilis pustulatis nullis. inflorescentia subcapitata, nuculis lineari-lanceolatis longior proprietaibus evidentibus minoribus.

Herbae perennes caespitosae. 1-3 dm altae; caules graciles. infirmi, 1-plures 0.7-1.8 dm longi. strigosi et setosi effusi pilis gracilibus infirmisque; folia lineari 2-13 cm longa. 0.1-0.5 cm lata. strigosa supra et infra. pilis pustulatis inconspicuis paucis dorsaliter; inflorescentia angusta. 0.2-0.8 dm longa; segmenta calycum linearia vel anguste lanceolata. sub anthesi 3-5 mm longa. sub fructu 7-10 mm longa. setis flavidis divaricatis; pedicelli 0.5-1 mm longi; corolla alba. tubo 3-3.3 mm longo cristis ad basi tubi conspicuis, fornicibus flavis emarginatis 0.5 mm longis. limbo 5-6 mm lato; stylus fructo exceedens ab 1.3-1.6 mm; nuculae lanceolatae 3.3-3.6 mm longae. 1.6-2 mm latae, pleurmque totae quatuor evolutar, marginibus acutis, contiguis pagina dorsalis muricata et rugulosa cristis humilibus inconspicuisque pagina ventralis similaris sed proprietaibus evidentibus minoribus; sulcus aperta. subulatus. marginibus sine elevatibus.

Caespitose perennial herbs. 1-3 dm tall; stems slender, weak, 1-several. 0.7-1.8 dm long. strigose and spreading setose with slender weak hairs; leaves linear. 0.1-0.5 cm wide. 2-13 cm long. strigose on both surfaces, and with a few inconspicuous pustulate hairs on the dorsal surface; inflorescence narrow. nearly capitate. 0.2-0.8 dm long; calyx segments linear or narrowly lanceolate. in anthesis 3-5 mm long. in fruit becoming 7-10 mm long, with yellowish spreading hairs; pedicels 0.5-1 mm long; corolla white. the tube 3-3.3 mm long, crests at base of tube conspicuous. fornices yellow. emarginate. 0.5 mm long, limb 5-6 mm broad; style exceeding mature fruit 1.3-1.6 mm; nutlets lanceolate, 3.3-3.6 mm long. 1.6-2

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Figure 1. Habit sketch of *Cryptantha shackletteana* showing the narrow leaves, capitate inflorescence, and both surfaces of a Single Nutlet.

mm wide, usually all four maturing, the margins acute, in contact, dorsal surface muricate and rugulose with the ridges low and inconspicuous, the ventral surface similar but the markings much less evident, scar open, subulate, and without an elevated margin.

Type. Locality; Alaska: On steep, southfacing slope of Eagle Bluff, about one mile northwest of Eagle. Growing with *Artemisia frigida and Agropyron smithii*, 26 July, 1968, Stanley L. Welsh and Glen Moore 8629. Holotype deposited at BRY.

Distribution. Apparently confined to the type locality near Eagle, Alaska. Growing on serpentine talus slopes, 1,000 to 1,500 feet. Flowering from June to July.

Specimens Examined. Alaska, USA, on dry slope of ultrabasic talus, Mission Bluff, Eagle area, 1,300 feet, June 26, 1960. Hansford T. Shacklette 6183 (US).

Cryptantha shackletteana is probably closely related to *C. spiculifera* but differs in the longer and narrower leaves with only inconspicuous pustulate hairs, the more capitate inflorescence, longer and narrower nutlets with less evident markings, and weaker stems.

This species is named in honor of Hansford T. Shacklette, who is a student of Alaskan Botany and Geology, and who was the first to collect this distinctive species.

2. *Cryptantha* subgenus *Oreocarya* (*Greene*) stat. nov.
(Based on *Oreocarya* Greene, Pitt. 1:57-58. 1887.)

Payson included all the species in this subgenus under the section *Oreocarya*, but if a sectional name is to be used it cannot be *Oreocarya*, but must be *Pseudomyosotis* according to the rules. Rather than use a sectional name all the perennial species have been elevated to the rank of subgenus.

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NEW RECORDS AND DISTRIBUTIONAL NOTES FOR REPTILES OF THE NEVADA TEST SITE[1]

Wilmer W. Tanner[2]

In 1963 Tanner and Jorgensen published their study, "Reptiles of the Nevada Test Site," and listed twenty-eight species for the Test Site. Since then four summer of intensive ecological activity in several of the habitat areas of the Test Site have added three additional species and increased our understanding of others. Two of the added species were listed as probable species in 1963, but the third was quite unexpected.

Dipsosaurus dorsalis dorsalis Baird and Girard

Three additional specimens have been taken, two from the Larrea-Franseria community in Frenchman Flat (can traps) and one DOR in western Jackass Flat. Although more widely distributed than originally reported, this species still remains one of those less commonly observed on the Test Site.

Sceloporus graciosus graciosus Baird and Girard

The northern Sagebrush Lizard reaches its most southern limits in the uplands of southern Nevada. Records from Pahute Mesa are now available. In this area we find the Pinyon-Juniper forests with open areas of desert shrubs of which *Artemisia tridentata* is usually present.

An ecological point of interest is the occurrence of *Sceloporus occidentalis* at the summit of Rainier Mesa well above the distribution of *S. g. graciosus*. The three species of *Sceloporus* at NTS have little overlapping of their habitat areas. *Sceloporus magister* is found in the flats and particularly on the upper bajadas and foothills that surround the broad valleys. *Sceloporus graciosus* has been found in the lower limits of the Pinyon-Juniper Community and *Sceloporus occidentalis* seems to occur primarily in the Pinyon-Juniper Community with the greatest concentrations in the higher elevations such as Rainier Mesa. In a narrow area along the eastern base of Rainier Mesa both *magister* and *occidentalis* have been seen on boulders which line the road. There may be other areas where their habitats overlap; however, it is quite obvious that all three exist for the most part as single species populations within their own habitat niche.

The complete range of *Sceloporus graciosus* for the Test Site is not yet known. Its occurrence in the Pinyon-Juniper-Artemisia

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[1] This study was supported by Research Grant (AT(11-1)1496 with the United States Atomic Energy Commission.

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plant associations would indicate its occurrence wherever these plants predominate. This would place the range in the northern parts of NTS and extending northward into central Nevada.

Morphological (meristic) characters of the small series available does not indicate any important differences from those series seen from central Nevada and southwestern Utah.

Leptotyphlops humilis Baird and Girard

In spite of extensive field work and can traps placed in what appears to be favorable habitat, only one specimen has been found. On May 19, 1964, one specimen (BYU 23929) was taken in Rock Valley (NTS) by A. P. Aschwanden. It has a total length of 282 mm and a snout-vent length of 270 mm. There are 14 rows of dorsal and 282 scales in the dorsal row; head scales are normal except that the fifth dorsal is noticeably wider than is usual in *humilis*.

The nearness of NTS to southwestern Utah and the fact that a specimen taken at Indian Springs (Clark County) was identified as *utahensis* (La Rivers, 1942) leads one to suspect that the subspecies *utahensis* should be at the test site. An examination of the scale counts as listed above, however, places this specimen as an intergrade *humilis* x *utahensis*. The dorsals fall between these two subspecies (*humilis* 265-280; and *utahensis* 289-308) and the fourth dorsal is not divided but the fifth is much wider than the sixth. Such intermediate characters indicate that one might expect to find at NTS individuals which would key to either subspecies or be intermediate.

Diadophis punctatus regalis Baird and Girard

An adult female (BYU 31287) was taken on July 14, 1968, along Holmes Road one mile from its junction with Stockade Wash Road, Rainier Mesa, by James M. Hopkin and Wilmer W. Tanner. Its peculiar behavior of coiling its tail so as to show the bright Carnelian Red color (Ridgeway 1912) on the caudals led to its capture. The snake was actually on the shoulder of the road; however, as we approached, the vibration apparently initiated the above behavior permitting Mr. Hopkin to see it as we passed.

The color and color pattern does not vary from the few live specimens seen from southwestern Utah and is the same as previously reported by Tanner (1952) for a specimen from Washington County, Utah. The ventral scale count of 235 is noticeably higher than has been observed in previous specimens from Nevada and Utah, however, the caudal count is lower thus producing a ventral-caudal total of 301 scutes. This is comparable to other specimens seen from the range of *regalis*.

This record extends the range for this species approximately 250 miles southwest from its previous record near Caliente, Nevada and for at least 300 miles west of the nearest locality in northwestern Arizona.

The apparent extensive range of this species seems to be restricted to those habitats associated with the scrub oak, Pinyon-Juniper or some combination of these plant communities. In western Utah and adjoining eastern Nevada these plant communities occur primarily between 4,500 to 7,000 feet elevation. At the Nevada Test Site such plant communities occur at higher elevations with the Pinyon-Juniper at a near climax on the higher mountains and mesas.

This specimen was found on the south slope of Rainier Mesa at an elevation of approximately 6500 feet and well within the Pinyon-Juniper community. On the basis of its occurrence on Rainier Mesa, I would expect it to be found or at least to inhabit other similar adjoining areas, such as Pahute Mesa, and to extend north and northeast into central and eastern Nevada.

Masticophis taeniatus taeniatus Hallowell

In 1963 only three specimens of this species were recorded for the Test Site. At that time it was indicated that the scarcity of records was undoubtedly due to the lack of collecting in the more desirable areas. During the period from 1965 to 1968 (3½ summers) only three additional specimens have been taken and two seen DOR.

All records are from areas in or near the Juniper-Pinyon pine habitat. Our records would indicate that this species (subspecies) is at its southern limits in the higher elevations of the Nevada Test Site and we do not expect to find it in the deseret valleys (Frenchman, Yucca, or Jackass Flats). Although this species is not what we might call a rare species, it is not a common one and may not be seen daily even though we traverse its habitat area.

Phyllorhynchus decurtatus parkinsi Klauber

We reported the first record of this species for Nye County, Nevada, in 1963 and indicated on the basis of the few specimens available (four) that it was perhaps one of the less common species on the Test Site. In the last few years, however, we have found this species to be one of the more common, particularly in the lower valleys. Certain areas in Frenchman, Mercury, and Jackass Flats have produced large series of specimens. We have noted that our greatest number of observations have occurred in those habitats where *Larrea* occurs as a part of the vegetative cover. It is now possible for us to provide a range of variation for some of the more common scale characters and these are as follows: Ventrals ♀♀, 10(178-190)183.5; caudals, 10(26-30)28.0. Ventals ♂♂, 16(165-176) 170.9; caudals, 16(33-40)37.5. In both the males and the females it will be noted that the above scale counts average less than those reported by Klauber (1935). The color pattern is essentially as reported for NTS specimens in 1963.

Hypsiglena torquata deserticola Tanner

In 1963 a single specimen was reported for the Test Site. Since 1965 a series of this species has been found by driving the roads in the evenings. Present records show it not to be a rare species, particularly in the lower foothill and bajada areas of the Test Site. The scale counts and color pattern, especially the dorsal spots and the nape spots, are essentially as reported by Tanner (1946).

Trimorphodon lambda Cope

A second specimen of this species was taken approximately one mile north of the junction between the NLRD road and the connecting road from Mercury. It is a male with approximately the same scale counts as reported previously. We have made a determined effort to find additional specimens of this species using methods which have been successful in other areas by other workers. We, therefore, must conclude that it really is a rare species at the Test Site and that it perhaps is very near its most northern distribution limits.

Tantilla p. utahensis (Blanchard)

A third specimen of this species was taken at Cane Springs in a can trap, 31 August, 1968. It is an adult male specimen with scale patterns that fit nicely into the averages as presented by Tanner in 1966. We are still not certain as to the abundance of this species but suspect that it is more common than our collecting records would indicate, particularly in the rocky foothills and gravelly bajadas. This specimen was taken on a rocky northeast slope.

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THE EFFICACY OF HALOXON AND THIABENDAZOLE AS ANTHELMINTICS AGAINST GASTRO-INTESTINAL NEMATODES IN SHEEP

Ferron L. Andersen[1], Keith H. Hoopes[2], and J. Carl Fox[3]

INTRODUCTION

Since many species of parasitic nematodes are picked up by the host grazing on contaminated pastures, control measures are generally directed towards proper range or pasture management as well as towards an appropriate animal husbandry program. In most areas where severe parasitism occurs, livestock owners must treat their animals several times each year with anthelmintic drugs in order to keep the animals as free of parasites as possible. Some of the problems which relate to drug treatment are not only the cost of the drugs and of handling the livestock several times each year, but also the fact that drug resistant strains of parasites frequently develop to routinely-used drugs.

Examination, in the fall of 1967, of the sheep kept at the BYU Research Farm at Provo, Utah, indicated that gastro-intestinal parasitism by certain nematodes could represent a serious problem. One yearling lamb died as a result of natural infection of the large stomach worm of sheep, *Haemonchus contortus*, on 22 September, 1967. This lamb had a count of 5,200 eggs per gram (e.p.g.) of feces, and exhibited other symptoms of haemonchosis, including edema of the head and thoracic and abdominal cavities. Other lambs killed on different experiments at this same approximate time also had several hundred *H. contortus* adults in the abomasum.

Since all of the sheep at the farm had been treated routinely during the past eight years with low levels of phenothiazine mixed in the feed, we decided to test the anthelmintic efficacy of Thiabendazole* and Haloxon**, two drugs which had not been used previously at the BYU Research Farm.

PROCEDURE AND RESULTS

On 30 September, 1967, we obtained fecal samples from 107 sheep maintained at the farm. Some of these sheep had been on

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*Thiabendazole is an imidazole derivative with the chemical formula of 2-(4'-thiazolyl) benzimidazole, and a product of Merck and Company, Rahway, New Jersey

**Haloxon is an organophosphate compound with the chemical formula of O,O-di-2-chloroethyl O-(3-chloro-4-methylcoumarin-7-yl) phosphate, and a product of William Cooper and Nephews, Inc., Chicago, Illinois.

This research was supported in part by a grant-in-aid from William Cooper & Nephews, Inc., Chicago, Illinois, through Dr. Paul V. Christofferson, D.V.M., Veterinary Director.

irrigated grass pasture during the entire summer, while others had been used on nutrition experiments, and had been held on drylot only. Those on drylot had only small numbers of eggs or none in the feces. Of those held on pasture, we were able to identify 25 adult sheep that had egg counts varying from 200 to 3500 trichostrongylid eggs per gram of feces. For the purpose of the experiment, these sheep were divided into three groups on the basis of the egg count. Group A, consisting of 8 sheep, had an average e.p.g. of 1028 (range: 200 to 2100) and on 19 October, 1967, each animal was given, by dose syringe, 1 fluid ounce of Thiabendazole mixture, containing 2 gm Thiabendazole per fluid ounce. Group B, consisting of 9 sheep, had an average e.p.g. of 1230 (range: 200 to 3500) and on 19 October, 1967, each animal received 1 fluid ounce of Haloxon containing 1.4 gm Haloxon per fluid ounce. Drug dosages were based on manufacturers' recommendations. Group C, consisting of 8 sheep, which had an average e.p.g. of 1300 (range: 200 to 3400) served as the control group. Fecal samples were collected again 12 days after treatment was given. At that time the average e.p.g. in Group A (Thiabendazole-treated) had dropped to 8 (range: 0 to 100), a 99% reduction in total egg count, Group B (Haloxon-treated) had dropped to 19 (range: 0 to 100), a 98% reduction, and the control sheep had also dropped to an average e.p.g. of 275 (range: 0 to 900), a 79% reduction. The average e.p.g. counts for all three groups of sheep prior to and 12 days after treatment are listed in Table 1.

In order to determine which genera of nematodes were affected by the drugs, larval cultures were made from all fecal samples from the 25 sheep prior to and after treatment. Table II shows the numbers of larvae examined and their assignment to various genera, based on the tables prepared for total length and sheath tail length by Dikmans and Andrews (1933) and Keith (1953). Our ranges of total and sheath tail measurements differed slightly from the tables we were using, but the identification of *Haemonchus*, *Chabertia*, *Ostertagia*, *Trichostrongylus*, and *Nematodirus* was considered valid.

From the results we obtained, it was noted that Thiabendazole was highly effective against *Trichostrongylus* and *Ostertagia*, since no larvae of these genera were detected after treatment. The percent of *Haemonchus* larvae constituted 67% of the larvae identified before treatment and 27% of those identified after treatment. The percentage of *Chabertia* larvae increased from 4% prior to treatment to 47% after treatment, and the percentage of *Cooperia* rose from 7% to 20%. Haloxon appeared completely effective in eliminating *Haemonchus*, *Cooperia* and *Ostertagia*, but not as effective against *Trichostrongylus* as was Thiabendazole. The percentage of *Trichostrongylus* in the Haloxon-treated group increased from 14% prior to treatment to 21% after treatment, *Oesophagostomum* rose from 2% to 5%, and 68% of all larvae identified after treatment from the Haloxon-treated group were identified as *Chabertia*,

TABLE I
Effect of anthelmintics on gastro-intestinal nematodes of sheep

Group #	No. of Sheep	Mean No. nematode eggs per gram feces before treatment	Treatment	Mean No. nematode eggs per gram feces after treatment
A	8	1028	1 fl. oz. Thiabendazole per sheep	8
B	9	1230	1 fl. oz. Haloxon per sheep	19
C	8	1300	Controls—no treatment	275

TABLE II
Gastro-intestinal nematode larvae identified in fecal cultures from sheep treated with anthelmintics

			Percentages of larvae before treatment*										Percentages of larvae after treatment							
Group #	No. of Sheep	No. larvae identified before treatment	Ha.	Tr.	Oe.	Ch.	Co.	Os.	Ne.	Un.	Treatment	No. larvae identified after treatment	Ha.	Tr.	Oe.	Ch.	Co.	Os.	Ne.	Un.
A	8	96	67	10	..	4	7	3	..	9	Thiabendazole	15	27	..	..	47	20	..	..	6
B	9	87	76	14	2	..	3	5	..	..	Haloxon	19	..	21	6	68	..	..	5	
C	8	96	68	14	4	5	3	6	..	..	None	79	39	27	3	6	18	5	2	

*Ha. =	Haemonchus
Tr. =	Trichostrongylus
Oe. =	Oesophagostomum
Ch. =	Chabertia
Co. =	Cooperia
Os. =	Ostertagia
Ne. =	Nematodirus
Un. =	Unidentified

whereas none had been identified in that group prior to treatment. The most significant change in the percentages of the various genera in the control sheep was a decrease in *Haemonchus* from 68%, prior to the time the two groups were treated, to 39% when the control sheep were sampled afterwards. The percentages of larvae identified as *Trichostrongylus* and *Cooperia* showed corresponding increases during this period.

Discussion and Conclusions

Although the variation in nematode egg counts was considerably greater than would have existed had we infected the sheep experimentally with equal numbers of infective larvae, this project, nevertheless, showed that both Thiabendazole and Haloxon are effective anthelmintics against the majority of gastro-intestinal nematodes encountered. It was unfortunate, however, that the problem was identified and started so late in the pasture season, since the marked drop in egg counts in the control sheep undoubtedly related to decreased numbers of infective larvae being picked up by the grazing sheep at that time of the year. *Haemonchus contortus* larvae in particular are highly susceptible to colder temperatures as demonstrated by the seasonal e.p.g. decline in the control animals, and generally do not develop from the egg to the infective larval stage at mean monthly temperatures of less than 65° F, or when the total monthly rainfall is less than 2 inches per month (Levine, 1963; Kates, 1965). The mean monthly temperatures in a standard weather shelter in Provo for June, July, August, September, and October, 1967, were 62.3, 73.3, 72.3, 62.6, and 47.9 F respectively. The total precipitation for those five months was 1.26, 0.96, 0.16, 0.77, and 0.55 inches, respectively. Therefore, the conditions for the development and survival of the free-living stages of *Haemonchus*, as far as available moisture was concerned, would appear to be considerably less than optimum for these months. The precipitation for these months in 1967 did not differ markedly from the long-term averages for Provo for the four main pasture months of June, July, August, and September, since these are all less than 1 inch per month. During this same period, however, farmers in this area put as much water on their lands through irrigation as that comparable to 20 inches of rainfall. Some of the lowland pastures are frequently completely saturated by irrigation water that may be allowed to run for several days in any one pasture location. These conditions of moisture, coupled with the fact that the soil temperature measurements may actually be 15-20° F higher than that recorded in a standard weather shelter (Andersen and Levine, 1967) certainly are capable of producing microenvironmental conditions optimum for the development and survival of these nematode larvae. Nevertheless, when the project herein reported was conducted during the late pasture season, the number of larvae available on the pasture would naturally be decreasing due to low temperatures. On the 13th and 14th of September the minimum daily temperatures in the weather shelter were only 29 and 32° F, respectively, and 6 of the 16 remaining days in September had minimum temperatures less than 40° F. These low temperatures, undoubtedly, would decrease the numbers of viable larvae on the pasture, thereby resulting in fewer new infections in the grazing sheep. Had the total egg counts from the control sheep remained at the same approximate level as that before treatment, the efficacy of the two anthelmintics tested would have been much clearer.

Since the numbers of larvae recovered from fecal samples following treatment was very limited in the two treated groups, the comparison of the effect of the drugs on the specific genera as determined by larval identification must be interpreted provisionally. No more than 100 eggs per gram of feces was noted in any of the treated sheep. With such small numbers, the recovery of sufficient numbers of larvae for identification after laboratory culture is very difficult, and only a total of 34 infective larvae were identified from these two treated groups. Nevertheless, as mentioned above, the identification of most of the genera was considered valid. Infective *Haemonchus contortus* larvae are particularly easy to identify and the fact that none of these were found in any fecal samples taken from the Haloxon-treated sheep seemed quite significant.

As stated above, one of the main difficulties in using continual chemotherapy as a control measure in parasitism is the frequent development of strains of the parasites resistant to the chemicals being used. Phenothiazine, for example, was first introduced as an anthelmintic in swine by Harwood, Jerstad and Swanson in 1938, and then by a number of authors in 1939 (See Gibson, 1965) as an anthelmintic in sheep. Early reports showed this drug to be 75-90% effective against *Haemonchus* when used in crude preparations, and later up to 100% effective when used in a micronized-powder form. Strains of *Haemonchus* resistant to phenothiazine were first reported in 1957 in Kentucky by Drudge, Leland, and Wyant, and later noted by such authors as Enzie *et al.* (1960) in Maine, and Levine and Garrigus (1961) in Illinois. In the latter case, phenothiazine had been used routinely at the sheep division at the University of Illinois for 19 years before the resistant strain was identified.

Thiabendazole was first introduced as an anthelmintic in sheep by Brown *et al.* in 1961. This drug proved to be an extremely effective broad-spectrum anthelmintic and has been used widely in many geographical locations for treatment of parasitic helminths. Efficacy against *Haemonchus* in sheep ranged as high as 96-100% (Hebden, 1961; Gordon, 1961). Since that time, however, strain resistance has appeared against this drug also. Smeal *et al.* (1968) recently reviewed accounts of resistance to Thiabendazole that have been noted in the United States and Brazil, as well as the work they reported on for Australia. Since 27% of the larvae recovered after treatment in the Thiabendazole-treated animals in our project were *Haemonchus*, there is at least some suggestion that the *Haemonchus* in this geographical area are also somewhat resistant to this drug. Since the drug has not been used at the BYU Research Farm, however, such a conclusion would imply that resistant strains have been brought to this area by sheep that have been purchased elsewhere.

The efficacy of Thiabendazole against parasitic helminths has been reported in several hundred scientific articles, and annotated bibliographies are available on this subject from Merck and Company, Inc., Rahway, New Jersey. Haloxon has not been tested as widely in the United States, but its efficacy against several genera of gastro-intestinal nematodes in sheep as well-documented by such authors as Armour, Brown and Sloan (1962), Harbour (1963), Barnett, Berger, and Rodrigues (1964), Turk, Galvin and Bell (1965), and Baker and Douglas (1965). In general, these workers found Haloxon to be a highly efficacious anthelmintic against most of the same genera of parasitic nematodes as was Thiabendazole, with the exception that it was not as effective against such genera as *Chabertia*, the large-mouthed bowel-worm, or *Oesophagostomum*, the large intestinal nodular worm. Haloxon is apparently hydrolyzed before it reaches the large intestine, and is therefore more effective against nematodes which occur in the abomasum and small intestine. We also found that Haloxon was not effective against *Chabertia* and *Oesophagostomum*, although as stated earlier, the small numbers of larvae identified suggests that this conclusion be interpreted provisionally.

Although comparative studies on the efficacy of phenothiazine were not included in this project, the fact that the animals had been treated routinely with phenothiazine for the past eight years, and yet the fact that severe haemonchosis can occur here, also suggests that strains resistant to this drug exist in this area. Experiments involving critical testing where worm counts and speciations can be made at necropsy after treatment with Thiabendazole, Haloxon, and phenothiazine should be conducted, before the problem of possible resistant strains in this area can be resolved.

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NOTES

LEPIDOPTERA OF THE NEVADA TEST SITE[1]

During ecological investigations by Brigham Young University at the Nevada Test Site between 1959 and 1965, many moths and butterflies were taken, mainly by incandescent and ultraviolet light-traps. Many of these were submitted to Dr. Jerry A. Powell, University of California at Berkeley, who kindly made some general as well as specific identifications as a basis for further studies with this difficult group of insects. These are reported herein. All listings are alphabetically arranged for convenience.

- Arctiidae
  - *Arachnis* prob. *picta*
  - *Pygaractia murina*
- Coleophoridae
  - *Heliodines* nr *sexpunctella*
  - *Scythris* (12 spp.)
- Cosmopterygidae
  - *Inga concolorella*
- Geometridae
  - *Caripeta* sp.
  - *Glaucina* sp.
  - *Phaeoura* sp.
  - *Semiothisa* nr *colorata*
  - *Stenaspilates* sp.
- Lasiocampidae
  - *Gloveria arizonensis*
- Noctuidae
  - *Agrotis ypsilon*
  - *Conochares* nr *arizonae*
  - *Conochares* nr *hutsoni*
  - *Grotella* sp.
  - *Oxycnemis* nr *gracillima*
  - *Phobolosia anfracta*
  - *Synedoida* sp.
  - *Triocnemis* sp.
- Papilionidae
  - *Cercyonis* sp.
  - *Pieris protodice*
- Plutellidae
  - *Abebaea* sp.
  - *Cerostoma* nr *angelicella*
  - *Cerostoma* nr *delicatella*
  - *Cerostoma* nr *flavistrigella*
  - *Plutella maculipennis*
- Pyralidae
  - *Dichozoma parvipicta*
  - *Dioryctria* nr *gulosella*
  - *Etiella zinckenella*
  - *Eumysia mysiella*
  - *Heterographis morrisonella*
  - *Hulstia undulatella*
  - *Jocara* sp.
  - *Loxostege albiceralis*
  - *Nephopteryx bifasciella*
  - *Ommatopteryx texana*
  - *Passadena flavidorsella*
  - *Salebriacus odiosellus*
  - *Sosipatra rileyella*
  - *Staudingeria albipenella*
- Sphingidae
  - *Celerio lineata*
  - *Sphinx dollii*
- Tineidae
  - *Acrolophus laticapitanus*
  - *Acrolophus variabilis*
  - *Acrolophus* (4 spp.)
  - *Dystospasta yumaeella*
  - *Myrmecozela* nr *obliquella*
  - *Tinea* sp.
- Tortricidae
  - *Decodes fragarianus*
  - *Eucosma bobana*
  - *Eucosma* nr *bolanderana*
  - *Eucosma rorana*
  - *Ofatulena duodecemstriata*
  - *Phaneta indagatricana*
  - *Phaneta setonana*
  - *Platynota labiosana*
  - *Platynota* nr *yumana*
- Unplaced
  - *Adela punctiferella*

—Donald M. Allred[1]

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[1] BYU-AEC publication no. COO-1355-20.

WISLOUCHIELLA PLANCTONICA SKVORTZ. (CHLOROPHYTA, VOLVOCALES), A NEW ALGAL RECORD FOR NEVADA

In 1925, Skvortzow described a monotypic genus of biflagellated green algae as *Wislouchiella planctonica*, and according to Smith (1950), the species is known only from California and a few sites in the states of the Mississippi River Valley. The genus is quickly distinguished by its strongly compressed lorica with broad wing-like expansions on both sides of the massive cup-shaped chloroplast. Four projections may be seen; two arise at the proximal end and extend upwards and forward slightly beyond the apex of the lorica while the two distal projections extend upwards and back from an insertion point near the base of the protoplasm. It is these projections and the wing-like expansions of the compressed lorica that characterize the genus *Wislouchiella*.

The Nevada record is based on *Reveal 1570*, collected at The Reservoir, about 0.5 miles north of the Buckboard Mesa Road and about 2 airline miles northwest of VABM Tippipah at an elevation of 5,200 feet, north of Shoshone Mountain, Nye Co., Nevada, 16 July 1968, and deposited in the algal collection at Brigham Young University. This site is a recent man-made reservoir and the collection was made during a dense algal bloom; only the one species was found.—James L. Reveal [1,2]

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[2] Work performed under Contract No. AT (04-1) Gen-12 between the University of California and the Division of Biology and Medicine, United States Atomic Energy Commission

THE INFECTION OF IMMATURE AQUATIC INSECTS BY LARVAL PARAGORDIUS (NEMATOMORPHA)

Most of the hosts recorded for immature *Pragordius sp.* have been terrestrial insects (Carvalho, 1942; Hyman, 1951). The discovery of an infection of larval *Paragordius* in the mayfly *Baetis* sp. (White, 1966) led me to examine more closely the other aquatic insects collected from Lawrence Creek, Adams Co., Wisconsin.

Fifty bottom samples, ¼m^2, collected each month during 1966 supplied the aquatic insects. Aquatic insects found to be infected with larval *Paragordius* are listed in the following table:

Table I

List of aquatic insects from Lawrence Creek, Wisconsin, infected with larval *Paragordius* sp, 1966.

Family	Genera	Months	% Collection Infected
Baetidae	*Baetis* spp.	IV, V	2.1
Leptophlebiidae	*Leptophlebia* sp.	IV, V	2.3
Ephemerellidae	*Ephemerella* spp.	IV, V, VI	4.1
Corixidae	*Sigara* sp.	IV	1.5
Brachycentridae	*Brachycentrus* sp.	IV, V, VI	1.2 no pupation
Simuliidae	*Simulium* spp.	IV, V, VI, VII	2.4 no pupation

Of the 83 genera of aquatic insects examined, 6 genera of 4 orders were found to contain larval *Paragordius*. The larval *nematomorphs* all appeared to be similar. The characteristics of larval *nematomorphs* are not well known but only *Paragordius varius* have been collected from Lawrence Creek.

Individuals that were parasitized showed several morphological variations from the non-parasitized individuals of the same genera. The wing pads of the Ephemeroptera nymphs were smaller than the average while parasitized. Simuliidae larvae were larger than average during June and July. The parasitized Simulliidae and Brachycentridae could not be induced to pupate in the laboratory while the non-parasitized larvae pupated readily.

From these observations I conclude that larval *Paragordius* can infect several different orders of immature aquatic insects of both holometabolous and hemimetabolous development.—David A. White, Assistant Professor of Zoology and Entomology, Brigham Young University, Provo, Utah.

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Volume XXIX, No. 2
July 31, 1969

The Great Basin NATURALIST

Published by
Brigham Young University

GREAT BASIN NATURALIST

The Great Basin Naturalist

PUBLISHED AT PROVO, UTAH BY
BRIGHAM YOUNG UNIVERSITY

VOLUME XXIX July 31, 1969 No. 2

THE ECOLOGY OF THE WESTERN SPOTTED FROG, *RANA PRETIOSA PRETIOSA* BAIRD AND GIRARD, A LIFE HISTORY STUDY

Ronald L. Morris and Wilmer W. Tanner[1]

INTRODUCTION

Numerous individuals have assisted in the preparation and completion of this study. We are indebted to Mr. Lawson Hamblin for allowing free access to his property where the main portion of this study was conducted, and to Dr. Frederick B. Turner for his suggestions and review of the manuscript.

We also thank Mr. David F. Avery for his help and for the data he furnished for the years 1962 and 1963, and also for photographs taken by him. Thanks also to the other students and staff who have helped in data analysis.

Since the turn of the century, the study of amphibian life history has received more attention than before; however, the natural history of many amphibians is still only partially known. Much of our knowledge is based upon laboratory studies where observations have been made on eggs obtained directly from the female as described by Rugh (1948) and as used by Johnson (1965), or directly from the pond as reported by Skousen (1952, unpublished). These types of studies provide for controlled conditions thereby giving a low variance to the results. They can also give an actual growth curve rather than an estimated one since the same individuals can be studied continually throughout their larval development. However, as stated by Bragg (1940a), to understand the reactions and behavior of an animal within its complex environment, one must still of necessity go directly to nature. Therefore, this study is based on an empirical approach.

REVIEW OF LITERATURE. Since the description of *Rana pretiosa* Baird and Girard, only limited life history accounts have appeared

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in the literature as compared to most other species of this genus in North America. Most references are small notes relating to distribution, habitat, or stomach content, and refer to populations occurring in Oregon, Washington, British Columbia, Wyoming, Idaho, and Utah. A brief summary is given by Stebbins (1951 and 1954).

Several accounts of *R. pretiosa* have appeared since the reports by Stebbins. Turner (1957) did a four year study from 1953-1956 on the ecology and morphology of *Rana pretiosa pretiosa* at Yellowstone Park in Wyoming, and Johnson (1965, unpublished) worked on the early development, embryonic temperature tolerance, and rate of development of *Rana pretiosa luteiventris* Thompson, from central Oregon. *Rana pretiosa* has also been included by Dunlap (1955) and Dumas (1966) in excellent works on the genus *Rana*. The influence of nerves in limb regeneration was studied by Thornton (1956) on *pretiosa* tadpoles taken at Moran, Wyoming.

Other earlier papers include Svihla's (1935) brief report on the eggs and tadpoles of *pretiosa* in Washington; Middendorf's (1957) observations on the frog's early spring activities in Montana; Carpenter's (1953a) brief ecological notes on *pretiosa* in the Grand Teton-Jackson Hole area of Wyoming, and his (1953b) notes on the aggregation behavior of the tadpoles. In a later study on amphibian movement, Carpenter (1954) found that there is a tendency for individuals to return to their original point of capture. Dunlap (1959) described briefly some morphological characteristics of *pretiosa* found in Deschutes County, Oregon.

The first published report of amphibians in Utah was by Yarrow (1875); however, no comprehensive work was done on the populations of Utah *Rana pretiosa* until Tanner (1931) included them in his work entitled, "A Synoptical Study of Utah Amphibia." The only other reports to include this species are those of Van Denburgh and Slevin (1915), Slevin (1928) who provides a description, and Skousen (1952) in which he characterized the eggs and larvae of Utah amphibians.

Taxonomic Status

Rana pretiosa was first described from Puget Sound, Washington, in 1853 by Baird and Girard. *Rana pretiosa luteiventris* was later described by Thompson (1913) from Anne Creek, Elko County, Nevada. Although *R. pretiosa* has been recognized as a valid species since its description, the status of the subspecies *luteiventris* has been questioned by several writers. Slevin (1928), for example, did not separate *R. p. luteiventris* from *R. p. pretiosa*. He based this decision upon the work of Van Denburgh and Slevin (1915) which stated that it was not possible to find constant differences in plantar or palmar tubercles between those specimens thought to be *R. p. luteiventris* from Utah and those *R. p. pretiosa* from Fort Klamath, Oregon, and Mount Rainer, Washington. Storer (1925) also questioned the validity of the subspecies *luteiventris* as did Stebbins (1951) when he stated, "it appears to be no more than a slightly differentiated subspecies of possibly very local occurrence." He did, however, recognize the subspecies *luteiventris* at this time. In a later work Stebbins (1954) did not recognize *luteiventris*, and in his latest work (1966) makes no mention of it.

Dunlap (1955) did recognize the two subspecies in his work on the variation within the genus *Rana* and states:

> *R. p. luteiventris* may be distinguished from *R. p. pretiosa* by the difference in coloration and by the foot tubercles. The bright color on the ventral surface is orange-yellow in adult *R. p. luteiventris*, and bright salmon-red in adult *R. p. pretiosa*. *R. p. luteiventris*, furthermore, lacks the tubercle at the base of the fourth toe, which is characteristic of *R. p. pretiosa.*

Dumas (1966) in his study on the Rana species complex also recognized the validity of the two subspecies. Livezey and Wright (1947) in their work on salientian eggs said that the eggs are entirely different between the two subspecies.

In Utah the subspecies has been recognized as *R. p. pretiosa* by most writers (V. M. Tanner 1927, Stejneger and Barbour 1943, W. W. Tanner 1940, Stebbins 1951, Schmidt 1953); however, certain variations have made its identification confusing. Skousen (1952) stated that the larvae of *R. p.* subsp. of Utah do not fit the description of *R. p. pretiosa* by Svihla (1935), but rather the description of *R. p. luteiventris* by Thompson (1913) and Svihla (1935). He also stated that the eggs are smaller than those of *R. p. pretiosa* of eastern Washington, and, therefore, suggested that the Utah population along the Wasatch front be called *R. p. luteiventris*. In a recent work Dumas (1966) summarized the distribution of *R. pretiosa* subspecies as follows:

> *Pretiosa* (sic) is found from northern British Columbia and southwestern Alberta southward through northern Idaho, western Montana, Washington, northern and western Oregon, and extreme northern California. *Luteiventris* (sic) occurs in southern Oregon, southern Idaho, western Wyoming, and in isolated pockets in northern Utah and northern Nevada.

Much of the confusion over the Utah subspecies is well founded and the decision one reaches in classification is largely determined by the stage of the life history which is studied. We have experienced similar difficulties in an attempt to classify Utah *pretiosa* by the diagnostic features given in the different taxonomic references. Livezey and Wright (1947) published a classification of anuran eggs of the United States and differentiated the *pretiosa* subspecies mainly upon: (1) the number of gelatinous envelopes surrounding each egg, and (2) the size of the eggs and number of the eggs per clutch. When special care is used in the observation of the jelly layers, Utah *pretiosa* key out to subspecies *pretiosa* because of their size and presence of the inner membrane. The differentiation of larvae is based upon the number and size of labial teeth rows. Tadpoles in this case, as pointed out by Skousen (1952), have two upper rows of teeth and fit the description of *luteiventris* by Thompson (1913) rather than that of *pretiosa* by Svihla (1935). The diagnostic characteristics used in the separation of adults are based upon coloration and the presence or absence of tubercles on the inner surface of the feet. The ventral coloration of live specimens range from orange to red which would place them as *pretiosa*, whereas tubercles are reduced and indistinct which is characteristic of *luteiventris*. Based upon the above information and the fact that some authors question the validity of *luteiventris*, we consider the Utah population to be *R. p. pretiosa* with a few aberrant characteristics which, as pointed out by Skousen (1952), may be the result of intergradation between the two subspecies. This possibility exists since both subspecies are present in the northern regions of the Great Basin and are approximately equal distances from the Utah population. In either case more work is needed on the taxonomy of the species, and the lines of distribution need to be established.

Life History and Ecology

Amphibians are used extensively in different experimental fields of biology and many times this is done without an understanding of the activities and life history of these animals in nature. This lack of information may also have a bearing upon other studies and their results. For example, Johnson (1965) studied temperature tolerance and developmental rate of *R. p. luteiventris* in the laboratory, but was unable to relate these to its distributional pattern based upon the breeding biology because of lack of information on *R. p. pretiosa* and other western species of ranids. In this study we are concerned with life history and breeding biology of *Rana pretiosa pretiosa* in Utah.

Study involves data which have been collected intermittently from 1962 to the spring of 1968 with the majority of the data collected regularly during spring and summer of 1966. This was done by following the activities of frogs from the time they emerged in the spring until offspring metamorphosed and hibernated in the fall. Observations and collections were made at regular intervals throughout this period of activity to provide a continuous record of growth and activity.

The study actually began in the spring of 1962 as a research project by David Avery, but was discontinued when eggs under observation were destroyed by children. The same study was resumed in 1963 except that all observations and measurements were obtained from eggs which were removed from the pond and taken to the laboratory where embryonic and larval development were observed in a 44 liter aquarium until metamorphosis was completed.

To gain a more complete picture of the life history of the western spotted frog, we obtained permission to study the frogs inhabiting the ponds on the private property of Mr. Lawson Hamblin (study area II) during 1966. This proved to be an ideal site, not only because of protected surroundings, but also because *R. p. pretiosa* is the only frog to use these ponds for breeding. As a result no difficulty was encountered in keeping separate the eggs and tadpoles from those of *R. pipiens brachycephala* which normally occupies the same waters in this area.

Extensive observations were made and specimens collected at these ponds during the spring and summer of 1966. This study is supported primarily by these data, supplemented by additional observations made by us and others both before and after 1966.

Study Areas

Observations on the western spotted frog were made primarily in the vicinity of Provo, Utah, along drainage areas of the Provo River at an elevation of approximately 4550 feet. A population of *R. pretiosa* along the San Pitch River three miles north of Fairview, Sanpete County, and one near Mona Reservoir in Juab County (collection records of adults only) are also included. The area used for this study is at the extreme southeastern extension of the range for *R. pretiosa* (See Stebbins, 1966) and includes those populations which have extended south from Snake River Basin in Idaho into the water courses along eastern edge of the Great Basin and the western front of the Wasatch mountains.

All study area were located after much field investigation, and can be characterized by several features which they have in common. Each site at which *R. pretiosa* has been observed was located, in relation to the local topography, in a low, swampy situation with some type of spring water supply nearby. Except for study area IV all sites were near the base of Provo Bench where water collects as a result of its relative position to the water table. Each observed site is a small permanent pond of water which has a continual source of water. Because of their low level and seep springs inflow, the ponds seldom have an external outlet; therefore, very little movement results because of flow of water through them. As a result each pond is made up of standing water with a deep silt or muck bottom in which frogs presumably hibernate during the winter.

Stonewort, *Chara sp.*, makes up the dominate aquatic vegetation and forms a complete mat covering over the bottom of the pond. Cattails, *Typha sp.*, are present in the deeper parts of each pond, and provide a cool, moist place for adult frogs to feed during the warmer summer months. By the end of June *Spirogyra sp.* is usually common in water providing an excellent place for hiding and a source of food for developing tadpoles, which can normally be found within or beneath floating vegetation.

Study area I was located near the old Provo Brick and Tile Company in a swampy area resulting from several small springs and seepage from higher irrigated lands. The three ponds used as breeding sites were all small ponds of standing water with seepage as the only inlet (Fig. 1). Several other ponds which were interconnected by small streams were present, but none of these were used by the frogs. Study area I has since been filled as a result of construction.

Fig. 1. Main breeding pond at study area I. Arrow indicates location of egg deposition.

Study area II is located at 2160 N. 750 W., 1 mile northwest of area I on property of Mr. Lawson Hamblin. This site consists of four man-made ponds, only two of which were used as breeding ponds. Pond A (Fig. 2) is the only one continually spring fed and therefore has a temperature several degrees lower than other ponds in this specific area.

Pond A measures approximately 5 by 8 meters, and has the smallest surface area. However, it is the deepest pond used for breeding at this location. The depth of the water at the north end is approximately 30 cm. and has a rocky bottom. The south end of the pond, where most of the adult frogs are concentrated, is approximately one meter deep and has a muck bottom. A thick growth of cattails

Fig. 2. Pond A at study area II. Arrow indicates location of egg deposition.

is present at this end. All the ponds are at the base of a 16 to 20 meter embankment (lake terrace) which extends along the west side. Willows growing thickly along the bank hang over the water for approximately one meter. A field with several species of grasses and weeds borders the ponds from the east. Pond B is located 30 meters north of pond A and is much larger, measuring approximately 12 by 21 meters. *Chara sp.* completely covers the bottom of the pond with only a thin layer of water appearing above it. The water is 15 to 45 cm deep with a muck bottom 60 to 90 cm deep.

Study area III is a drainage area from higher irrigated lands and is located west of Provo along the D. & R.G.W. Railroad tracks at approximately 1000 N. and 2100 W. (Fig. 3).

Study area IV (Fig. 4) is the highest elevation 5350 ft., at which observations were made in the Provo River drainage area. It is located on the south fork of Provo River approximately one and one-half miles east of Vivian Park, Utah County. These are permanent spring-fed ponds which have been impounded by man for a water storage area.

Several observations were made on a population of *Rana pretiosa* along the San Pitch River in Sanpete County. This population as reported by Tanner (1940) is the farthest south that this species has been collected. The elevation is approximately 6140 feet and because of the cooler temperature, eggs are laid about two weeks later than they are near Provo.

All ponds exhibit a basic reaction as shown by the pH readings in Table 1.

Fig. 3. Habitat of study area III. Arrow indicates location of breeding activities.

Fig. 4. Hatitat of study area IV.

Table 1. The pH readings taken from study areas.

Location	pH Reading
Study area I	7.45
Study area II pond A	7.50
Study area II pond B	8.48
Study area III	8.52
Study area IV	8.42

Methods and Procedures

Intensive field work has been carried out for the past three years beginning in the early spring months during 1965 to 1967 for the purpose of locating suitable habitats and noting the first dates of emergence. Temperature data taken from the ponds were later compared with temperature data obtained from United States Department of Commerce Weather Bureau Climatogical Data Reports for Provo and Geneva, Utah, to determine the physical conditions of the environment which released frogs from their hibernacula.

Daily observations were made on the breeding and egg laying habits after their spring appearance. Photographs were taken of eggs and mating frogs, and recordings made of breeding call of males in the field with a model 301 Martel Tape Recorder.

All egg clutches were measured in the field and left in their natural surroundings. Clutch dimensions were measured to the nearest centimeter by means of a metric ruler. Volume was determined by water displacement in a 500 ml graduated cylinder. Several eggs were taken from each clutch, preserved in 10 percent formalin, and removed to the laboratory where each egg was examined and measured individually to the nearest 0.1 mm with a 10 power magnification of a dissecting microscope equipped with an ocular micrometer.

To facilitate viewing of the inner membrane of the eggs, several techniques were employed. One such method, useful in the field, was to float a few eggs over the surface of the water in a small, white enamel pan, and then to observe the shadow cast by each membrane on the bottom of the pan when placed in direct sunlight. Although this method was successful for fresh eggs, it was not satisfactory for preserved eggs because of irregular shadows resulting from distortions in the outer surface. Another technique which proved very useful was staining. This was accomplished by first embedding individual eggs in dental impressive material, Hydrocolloid Algenate, according to directions on the label. After approximately four minutes the capsule was cut with a razor blade as close to the center of egg as possible. A drop of either Congo Red or Giesman stain was then placed over the exposed surface for one or two minutes and then removed. The resulting ring or rings within the jelly could then be observed and measured under a dissecting microscope.

Tadpoles were collected randomly at regular intervals and preserved in 10 percent formalin, and all measurements were taken to the nearest 0.1 mm as follows: head-body length, from tip of snout to the midpoint of cloacal opening; tail length, from midpoint of cloacal opening to tip of the tail. Total length was derived from the sum of the body and tail lengths; widths were taken at widest part of the body. Weights were taken on a Mettler electric balance and read to the nearest 0.1 mg and estimated to the nearest 0.01 mg; tadpoles were placed on blotter paper for 15 seconds after removal from the formalin before weighing.

Egg numbers were obtained by three different methods: (1) by counting eggs in each clutch after ovulation, (2) by counting the number of eggs in a given volume and then measuring the volume of the whole clutch, and (3) by actual count of eggs dissected out of mature females collected at intervals during late summer of 1966 and early spring of 1967.

Some difficulty was encountered during 1965 in locating tadpoles because of the dense growth of vegetation. To facilitate their collection, a small mesh wire screen was placed around the eggs at study area II on March 26, 1966 (Fig. 4 and 5). The screen was approximately 8 meters long and made a semi-circle in the water. The open end of the screen was approximately 3 meters long. The water level at pond A increased progressively during the summer so that it provided no barrier late in the summer. The effect of the screen at pond B is discussed in conjunction with larval development.

Analysis of dissolved minerals in water taken from the ponds was obtained through a measurement of conductivity with a salt bridge. Results are expressed in parts per million.

Hydrogen-ion concentrations were determined with an electric pH meter in the laboratory.

Discussion

The first appearance. The western spotted frog emerges from hibernation normally during the middle of March when the air temperature has risen to 13-16° C for several days or after a rain storm which has warmed the water sufficiently (Fig. 5-8). Spotted frogs appear about one week after the chorus frog *Pseudacris nigrita triseriata* which has been the first anuran to appear in the spring within the time covered by this study. The emergence of the leopard frog *R. pipiens* normally follows *R. pretiosa* by 7-10 days so that by the end of March the chorus frog and both ranids are present in the ponds often in large number. The peaks of the spawning seasons for these species, however, normally do not overlap in a given habitat at the same general elevation.

During the course of this study, earliest record of appearance for *R. pretiosa* was March 6, 1967. The seasonal temperature was unusually warm during this time. More important, however, than the air temperature itself is the temperature of the water under which the frogs hibernate. A temperature of 10-11° C seems to be a critical point in their activity. Not only must the water reach this tempera-

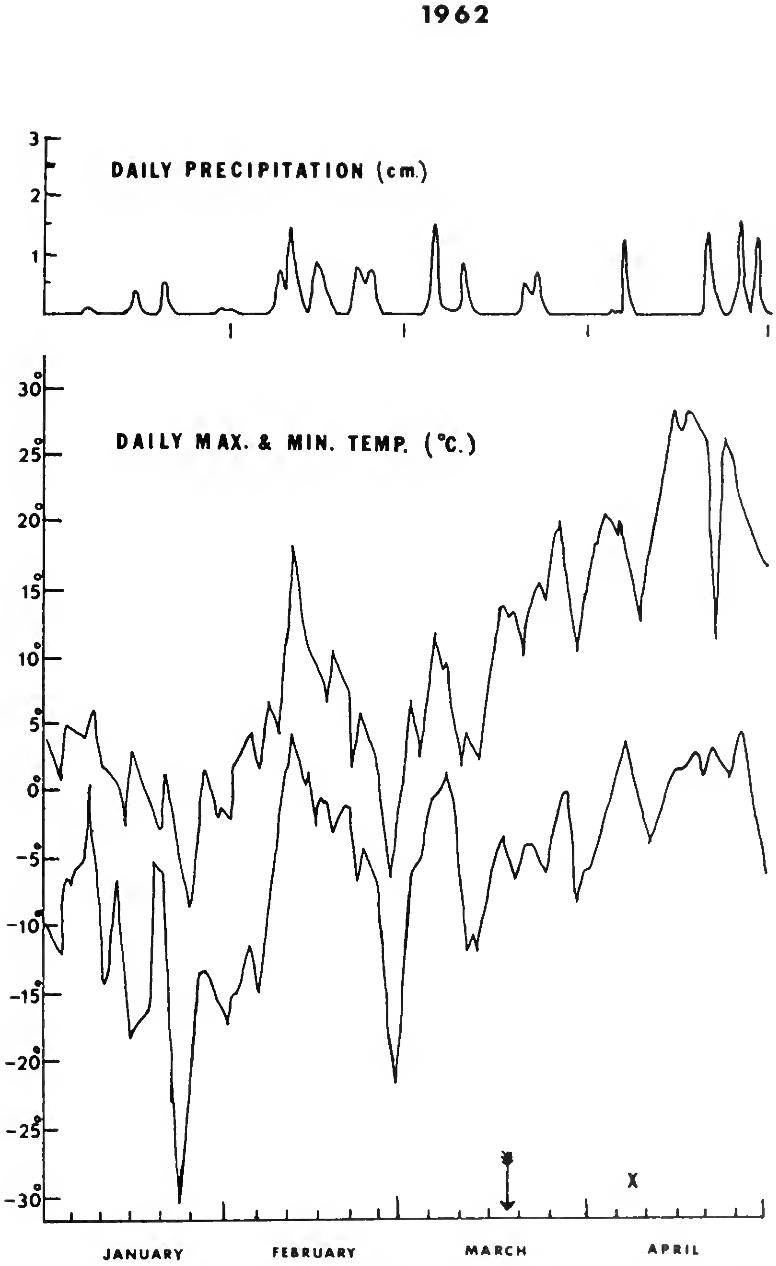

Fig. 5. Climatic data for the spring of 1962. Arrow indicates approximate date of emergence; X indicates approximate date hatching began.

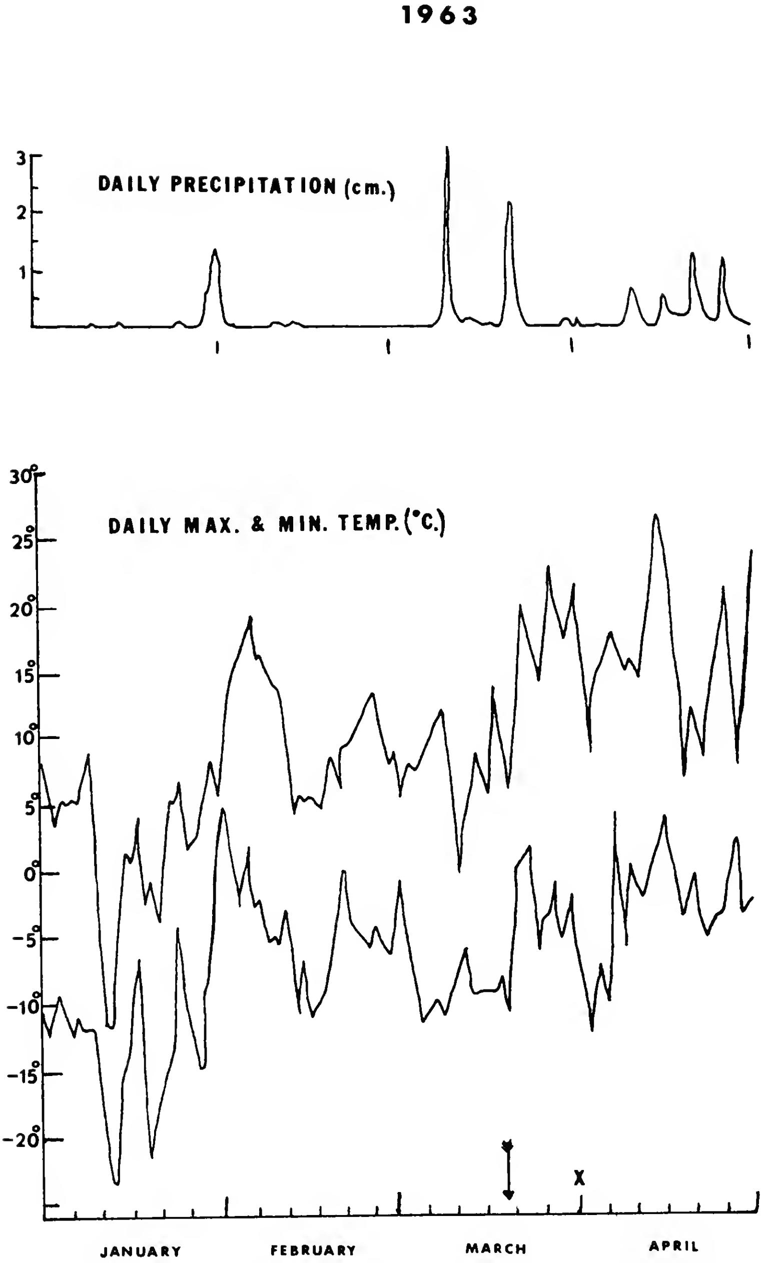

Fig. 6. Climatic data for the spring of 1963. Arrow indicates approximate date of emergence; X indicates approximate date hatching began.

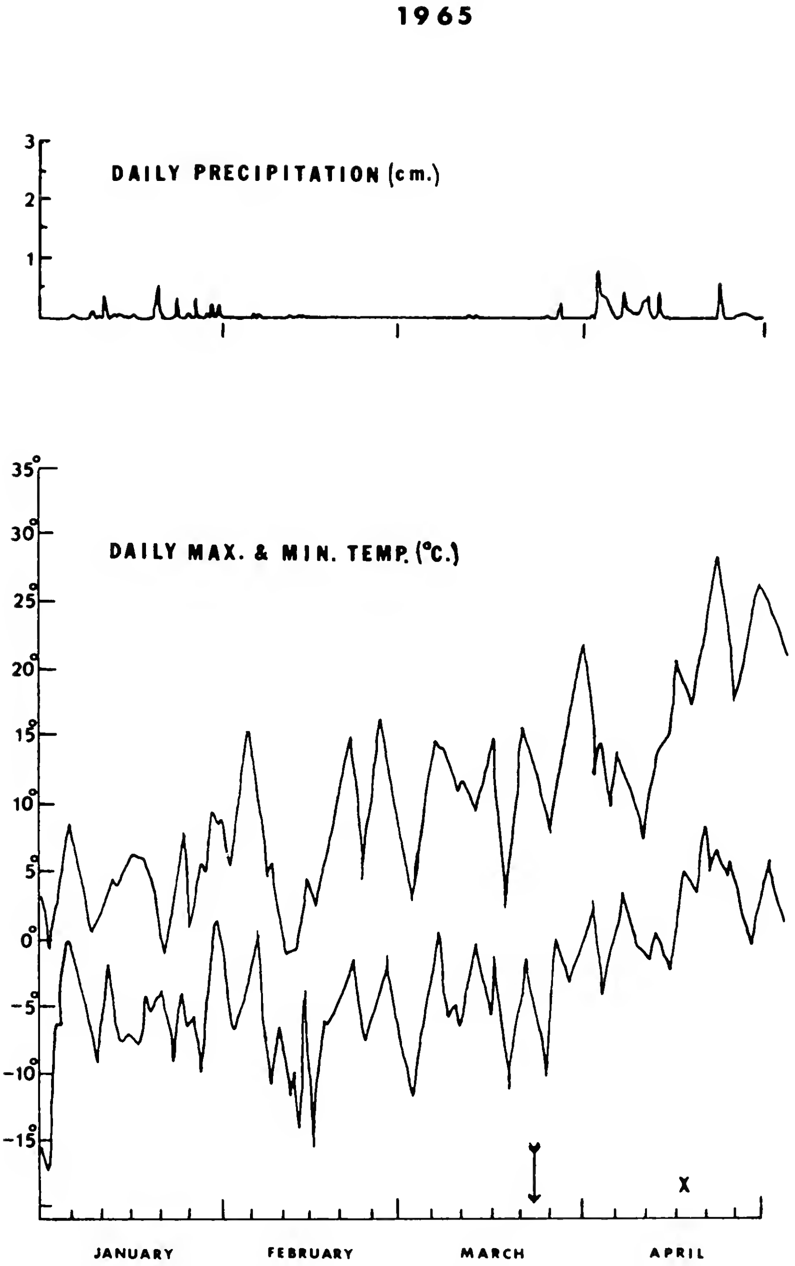

Fig. 7. Climatic data for the spring of 1965. Arrow indicates approximate date of emergence; X indicates approximate date hatching began.

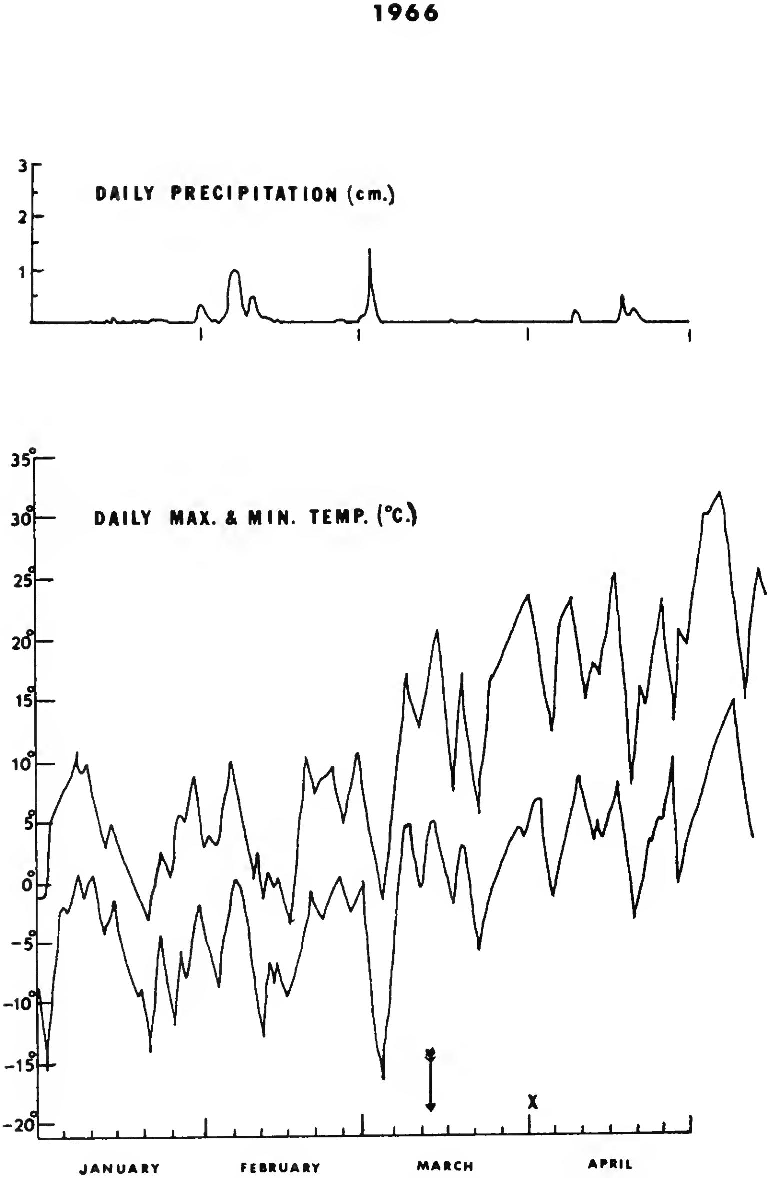

Fig. 8. Climatic data for the spring of 1966. Arrow indicates approximate date of emergence; X indicates approximate date hatching began.

ture to release them from hibernation, but when early morning temperatures fall below 10° C, or during a cold period causing a similar drop, frogs are not found at the surface of the water. Dredging of the bottom of the ponds reveals their presence in a semidormant state. As the temperature of the water again warms to 10° C they can be seen resting in vegetation just under the surface of the water. As the temperature warms to 11° C they will come to the surface.

There are undoubtedly other factors involved in stimulating their release from hibernation. The effect of moisture has been mentioned by both Vernberg (1953) and Martof (1953) as being important in releasing amphibians from hibernation.

During the spring of 1966 and 1967 it was noticed at two separate locations that frogs were appearing later in those ponds where the water level had dropped so that in the more shallow portions of the ponds the bottom was exposed. There may have been several factors involved in their retarded arrival, two of which may have been a lower temperature or a greater fluctuation in temperature because of a smaller quantity of water. This is an area of study open to further investigation. However, one item was noted, namely that these receding ponds showed a greater concentration of soluble salts, approximately 100 ppm higher than the others. This may possibly provide a type of physiological dryness to the frogs causing a delay in their appearance.

The males are first to appear and are present three or four days before the larger females emerge. The smaller immature frogs do not appear for two or three weeks after the females or until the breeding season is completed.

A summary of measurements taken on 36 frogs collected and released at study area II, pond A, on March 27, 1966, can be found in Table 2.

Table 2. Measurements of postbreeding frogs taken March 27, 1966, from study area II, pond A.

Sex	Number of specimens	Snout-vent length in mm	
		Range	Mean
Female	5	78.6-61.6	70.0
Male	25	64.2-47.2	49.9
Immature	6	42.6-31.0	37.8

As males emerge they do not exhibit much activity and can be found either calling from the pond with only their heads above water, or buried in vegetation during a cold period.

Vocality. The call itself closely resembles the sound made by repeatedly clicking the tongue against the top of one's mouth. The calls come in a series of clicks ranging in number from six to approximately 50. The rate of the notes varies depending upon the temperature. An examination of several calls made at 16° C showed a variance in rate of from 300 notes per minute to 480 notes per minute by different males. The duration of an individual call is from 4-10 seconds and repeated at a rate of as many as 10 calls per minute. With each note the floor of the mouth is depressed approximately 2 or 3 mm. The call can be given either above or below the surface of the water with the call from below the surface being somewhat louder. The call is weak and is muffled when other anuran species are calling from the same pond. The maximum distance for hearing the call is somewhat less than 25 meters, the average being 7 to 10 meters. The call of one male has been observed to stimulate others to call. This was noted after the frogs had been disturbed and many moved to the bottom of the pond. As one came near the surface and called, other frogs came from under the vegetation and swam to the top as if responding to a signal; soon all were at the surface and calling again. Normally at this time they pay little attention to any movement around the pond, even to the point that many can actually be touched before they attempt to escape.

Mating. Mating takes place immediately upon the arrival of the female as evidenced by the following: (1) at no time was an adult female observed to be present which was not in amplexus until after ovulation, and (2) the aggressiveness with which males attempt amplexus would require only a few minutes before a receptive gravid female would be clasped. The sexual drive is very strong in males of this species, so much so that not only do they attempt amplexus with others of the same sex, but at times two and three males have been observed embracing one female (Fig. 9); however, this multiple

Fig. 9. Multiple embrace of two males with one female. Note typical position of calling males at breeding sites.

embrace lasts for only a few minutes. The drive is so strong that attempted amplexus has been observed with other objects in the water, even to the point that one male, rather than escaping as it was reached for, swam closer and clasped onto my finger. The tenacity to mate is no doubt correlated with competition exerted by the large male to female ratio, and the fact that this species is very gregarious with all of the breeding activity limited to a small area within the pond. Of 30 adult frogs collected on March 27, 1966, there was a 1 to 5 female to male ratio (Table 2).

The difference in size between the larger females and smaller males (Table 2) places the vent of the males directly above that of the females during amplexus. Amplexus is axillary with the male embracing from above.

Ovulation. The females are apparently ready for ovulation as soon as they emerge and several clutches of eggs have been observed the same day. The eggs are normally laid at a water temperature of approximately 14° C and may be laid during the day or night. In nature, egg-laying has been observed to be interrupted for several days during a cold period, but would proceed as soon as the water again warmed to the approximate temperature. The embrace is maintained during the entire period. Experimentally males have maintained the clasp in the laboratory during a lowering of temperature almost to the point of freezing at which time the clasp was slowly released. Throughout the entire period of amplexus, the male's main physical activity seems to be to maintain the clasp until ovulation. All activities, such as protection and movement into deeper water during cold periods, are dependent upon the action of the female. The male remains passive during the entire period.

Fertile eggs have not been taken from a clasping pair which have been removed to the laboratory. This artificial condition seems to inhibit the females from laying even though the males have maintained their embrace for as long as two weeks.

The actual process of ovulation has not been observed in nature, although eggs have been found before the first cleavage has taken place. An examination of a clutch of eggs collected March 29, 1966, at study area III, showed that some eggs were attached together by a small gelatinous chord 2 to 3 mm in diameter as reported by Turner (1958), whereas the surfaces of adjacent eggs were attached directly by 3 to 5 mm of their outer membrane. A close examination of a typical egg revealed that it was connected to five other eggs. Two of these adjacent eggs were attached by means of the gelatinous chord, while the other three were attached directly by their outer membranes. As eggs are laid the adhesive character of the membranes causes them to become attached to one another and form one large, irregular clump. They also weakly adhere to vegetation below them as they come in contact with it.

Oviposition sites. The sites used for egg laying have several characteristics in common: (1) they are normally in the part of the pond which has warmest temperature resulting from solar radiation, and in most instances this is on the west side where the eggs catch the morning sun; (2) the eggs were always laid in an open area in clear water and never in among the cattails or in floating *Spirogyra* which was oftentimes only a few feet way; (3) eggs are usually in the shallow portion of the pond 10 to 20 cm under the surface of the water and attached to *Chara sp.* This attachment is rather weak, however, and within a week the clutch usually breaks loose and floats on the surface where the eggs become more of a flattened mass and are scattered by wind and water movements.

As one clutch of eggs is laid, there apparently is a stimulation for other females to lay their eggs in the same area. This behavior was best shown at study area IV where approximately 50 clutches of eggs were laid within an area 75 cm in diameter, even though other apparently ideal locations were available. This large assemblage of eggs was weakly attached, one to another and to the vegetation (Fig. 10). In this large pond area only a few clutches were found away from the large mass of eggs.

Eggs. During the spring of 1965, 10 clutches of eggs were measured and counted in the field (Table 3). The average number of eggs per clutch was 605. The largest clutch contained 725 eggs and the smallest 430 eggs.

In 1966 eggs in 21 different clutches were counted and measured (Table 4), and the average number per clutch for this year was 746. The maximum was 1160 and minimum 147 eggs per clutch.

Fig. 10. Oviposition site at study area IV. Note the closeness of egg masses (approximately 50 clutches).

Table 3. Comparison of clutch size and number of eggs collected from study area I on March 30, 1965.

Total no. Eggs per clutch	Clutch size in cm	Diameter of eggs in mm	
		Egg	Outer Mem.
541	9-8-5	2.5	10.0
625	9-7-5	2.3	10.1
695	11-8-7	2.4	10.5
715	10-8-7	2.5	13.0
615	12-9-9	2.5	10.0
635	11-9-7	2.4	10.0
650	13-9-7	2.5	13.0
725	11-6-6	2.2	10.7
514	6-5-3	2.1	12.0
430	5-4-2	2.3	11.0

Table 4. Relationship of clutch volume and number of eggs per clutch.

Locality	Date	Total no. eggs per clutch	Clutch volume in cc	Eggs per cc of clutch
Study area II pond A	24 March 66	940	320	2.62
		660	110	6.00
		500	105	5.24
		900	215	4.37
		950	400	2.38
	29 March 66	600	400	1.50
		840	415	2.02
Stury areaII pond B	29 March 66	716	285	2.58
		900	475	1.72
		148	130	1.13
		1160	550	1.11
	30 March 66	980	500	1.96
	31 March 66	655	325	2.01
		625		
Study area III	23 March 66	900	285	3.17
		925	230	3.96
		380	115	3.30
		460	100	4.60
Study area IV	5 April 66	990	250	3.96
		716	235	3.05
		730	375	1.98

Because of the great variation in egg numbers and because the numbers were consistently lower than those reported by such workers as Svihla (1935), Livezey and Wright (1947), Wright and Wright (1949), and Stebbins (1951), it was suspected that perhaps these frogs were laying a small number of eggs at one location and then producing others later, as was reported by Bragg (1944) for the common leopard frog in Oklahoma. However, in the dissection of gravid females of *R. p. pretiosa* from Utah County, this same variation in numbers has been observed before any eggs had been laid (Table 5). Therefore, it is reasonable to assume that Utah populations produce a smaller number of eggs for each complete clutch.

Table 5. Comparison of egg numbers and size of females collected from study area II, pond A.

Date	Total no. eggs per clutch	Clutch volume in cc	Eggs per cc of clutch	Total length of female
27 July 66	902	80	11.3	74
19 August 66	763	50	15.2	73
13 September 16	168			67
7 October 66	860	60	14.4	70
8 October 66	1060	72	14.7	64
15 October 66	393	40	11.2	59

We are unable to explain the reason for variation in the number of eggs per clutch. The size of females does not reliably explain the variation in clutch size.

Freshly deposited eggs soon increase in volume by absorption of water, so that within several hours after laying they may range from 110 cc to 550 cc with the average of those measured being 291 cc. Clutches of the same age are variable as to size and number of eggs per cc as is indicated in Table 3.

Several days after being deposited, a clutch usually appears as an irregular, oval mass just under the surface of the water. Within about a week egg mass becomes less coherent, and breaks loose to float at the surface in more of a plinth shape. By the time the eggs are ready to hatch they are almost undiscernible from above, because of the accumulation of dirt and debris on the exposed surface and the breaking up and amalgamation of the adjoining jelly masses. There is also a dry, crusty appearance to the mass resulting from destruction of 10 to 20 percent of surface eggs. This high mortality rate among the eggs is a result of several factors. First, the eggs are laid early in the spring so that there are many nights in which they become encrusted in ice which destroys some of them. Also, because of the long period of embryonic development they may later be forced out of the water by the new growth of submerged vegetation, which exposes the top eggs to desiccation.

Each egg is enclosed in two gelatinous envelopes separated by an indistinct inner membrane. The total diameter of the outer capsule normally varies within a range of from 9.0 mm to 13.0 mm although variations as great as 8.0 mm to 21.0 mm have been measured. The average diameter of those eggs measured (Tables 3, 6-9) was 10.0 mm. The diameter of the indistinct inner membrane has a normal variation of from 3.8 mm to 6.1 mm and a mean of 5.0 mm. This membrane is difficult to see in the fresh eggs without the techniques employed as described previously, but can be seen even in unfertilized eggs if these methods are used. As development progresses this inner membrane becomes more obvious because of the infestation of algae from the outside which stops at the inner membrane. If eggs fail to develop the ovum deteriorates clouding the inner jelly coat out as far as the inner membrane.

Table 6. Measurements in mm of eggs collected March 29, 1965, at study area I.

Egg Diameter		Capsule Diameter
	Inner	Outer
2.7	5.0	10.0
2.8	6.0	13.0
2.7	4.9	12.0
2.6	5.0	10.0
2.0	4.7	11.0
2.5	4.9	11.0
2.4	3.8	11.0
2.1	4.5	10.0
3.0*	8.0*	21.0*

*Extremely large egg

Table 7. Measurements in mm of unfertilized eggs laid in the laboratory by a female collected March 27, 1967, at study area III.

Egg Diameter		Capsule Diameter
	Inner	Outer
2.5	4.7	9.0
2.4	4.7	9.0
2.6	4.9	8.0
2.7	4.8	10.0
3.0	5.0	11.0
2.8	5.0	12.0
2.8	5.0	12.0

Table 8. Measurements in mm of eggs collected March 29, 1966, at study area III.

Egg Diameter		Capsule Diameter
	Inner	Outer
2.6	6.0	11.0
2.5	6.1	10.1
2.4	5.2	10.0
2.4	5.0	8.0

Table 9. Measurements in mm of eggs collected April 5, 1966, at study area IV.

Egg Diameter		Capsule Diameter
	Inner	Outer
2.6	5.0	10.6
2.6	5.0	10.5
2.6	3.0	10.0
2.7	5.1	10.3
2.6	5.0	10.3
2.5	4.5	10.2
2.4	4.9	10.1

The ovum is normally 2.5 mm in diameter, but does vary within a range of 2.1 to 2.9 mm. Preservation can cause some distortion in size if not done properly and may account for some of the variation shown in Tables 3, 6-9. The color of an egg is dark brown to black above, and pale yellow or light tan below. The vitelline membrane is closely applied to the ovum at time of hatching, which allows an enlargement of the fluid-filled chamber for embryonic development and movements.

As the embryonic development progresses, the embryo becomes progressively longer until at the time of hatching it is 8 to 10 mm in length. An attempt to analyze the physical factors involved in the actual hatching process has not been made. Discussions of these factors are given by Noble (1954) and Bragg (1940a, 1940b). A change in temperature was observed to have a noticeable influence on the hatching process. This was demonstrated when eggs placed in a natural spring did not hatch even though embryonic development seemed to be complete. The temperature of the spring water remained constant, at approximately 11° C, with only minor fluctuations. Samples of these eggs when removed from the cold environment would hatch in approximately one hour while those left in the spring hatched 7-10 days later. Eggs which were brought into the laboratory hatched at room temperature in about seven days, whereas those in nature and subject to the lower temperatures required from 13 to 23 days to hatch. Under normal pond temperature where the eggs were laid, the majority hatched about two weeks after ovulation. However, length of time required for hatching varies from year to year depending upon the fluctuations of atmospheric temperatures and the amount of cloud cover which reduces solar radiation.

LARVAL PERIOD. The hatching activities cover a period of several days, with most eggs hatching within three weeks after ovulation. The tadpoles remain attached to the gelatinous material by their oral suckers for two or three days following hatching. As they break loose from the jelly they sink to the bottom where only an occasional swimming movement is made. The results of ciliary movement along the body surface keeps a fresh supply of oxygenated water flowing from anterior to posterior past their external gills, as observed under a dissection microscope (30x mag.). The mouth and anal openings do not develop until one or two days following hatching. Actual feeding begins in conjunction with the first swimming activities. Associated with this free feeding stage, an operculum develops over the external gills and water is taken in through the mouth and out the spiracle on the left side of the body. The food eaten is mostly secured by scraping or rasping off the loose outer surface of decomposed plant material, a function for which the teeth are well adapted.

The rows of larval teeth are two upper and three lower as described by Skousen (1952) except that in a high percentage of the specimens measured, the first lower row was continuous rather than divided medially. For a more complete discussion on the development of larval mouth parts see Johnson (1965). An examination of the digestive tracts of several larvae show mostly decomposed material and some green algae. Tadpoles in the laboratory have been raised on live *Spirogyra* which gives a green color to the digestive tract. Burke (1933) was able to raise *Rana pretiosa* tadpoles through metamorphosis on a 24 hour mixed culture of bacteria. He concluded that the common water bacteria contain all the food factors necessary for their normal growth. The scavenger feeding of tadpoles advanced beyond stage 26 (Table 10) was further observed as they ate the remains of dead *pretiosa* tadpoles.

Table 10. Summary of developmental stages.

Stage 1: Egg fertilization
Stage 2: Appearance of the Gray Crescent
Stage 3: Two cells (first cleavage)
Stage 4: Four cells
Stage 5: Eight cells
Stage 6: 16 cells
Stage 7: 32 cells
Stage 8: Mid cleavage
Stage 9: Late cleavage
Stage 10: Beginning of gastrulation
Stage 11: Involution at dorsal lip
Stage 12: Blastopore complete
Stage 13: Neural plate develop
Stage 14: Neural folds and groove formed
Stage 15: Beginning of ciliary rotation, closing of neural fold
Stage 16: Neural tube formed, gill plates discernible
Stage 17: Development of tail bud
Stage 18: Muscular movement
Stage 19: Heart beat
Stage 20: Gill circulation
Stage 21: Cornea becomes transparent, mouth opens
Stage 22: Tail fin circulation
Stage 23: Opercular fold formed
Stage 24: Operculum covers right gills
Stage 25: Operculum covers left gills
Stage 26: Hind limb bud appears
Stage 27: Limb bud length equal to or greater than one-half the diameter
Stage 28: Limb bud length equal to or greater than diameter
Stage 29: Limb bud length equal to or greater than one and one-half the diameter
Stage 30: Limb bud length equal to two times the diameter
Stage 31: "Foot" becomes paddle shaped
Stage 32: Indentation formed for fourth and fifth toes
Stage 33: Indentation formed between third and fourth toes
Stage 34: Indentation formed between second and third toes
Stage 35: Indentation formed between first and second toes
Stage 36: Beginning of toe separation
Stage 37: All toes separated
Stage 38: Appearance of metatarsal tubercles
Stage 39: Subarticular tubercles appear as light patches on the inner surface of the foot
Stage 40: Subarticular tubercles fully developed
Stage 41: Loss of cloacal tail piece, "skin window" appears for forelimb
Stage 42: Forelimbs free
Stage 43: Angle of mouth midway between nostril and eye
Stage 44: Angle of mouth below midpoint of eye
Stage 45: Angle of mouth posterior to eye, tail stub remains
Stage 46: Metamorphosis complete

The actual growth of tadpoles, like that of the unhatched embryos is greatly influenced by different temperatures (King, 1903; Moore, 1938; Brattastrom, 1963; and Johnson, 1965). Tadpole activities at the early stages indicate that they employ to some extent a biological control of their temperature by their position within the pond. The young tadpoles prefer to stay close to the bottom and do so in the shallower areas where water temperature during the day is warmer. Aggregations of tadpoles have been noted at various times throughout the summer and as suggested by Carpenter (1953b) and Brattstrom (1962) these close aggregation may contribute, because of their melanistic color, to the warming of their immediate surroundings by absorption of solar radiation which in effect speeds up development leading towards metamorphosis. On overcast and rainy days tadpoles move to deeper water and are usually within the vegetation. By stage 30 (Table 10) they become more active, continually swimming and feeding throughout the pond. This activity continues until metamorphosis at which time a modification of the digestive tract permits them to feed closer to the shore on small arthropods, and to rest in the vegetation.

SUMMARY OF DEVELOPMENTAL STAGES. To facilitate a description of the developmental process taking place in embryonic (prefeeding stage) and larval (free feeding stage) frogs, staging tables have been used. They are of value in a life history study since the external morphology of each stage of development is described and illustrated. These staging tables have been used for some time by authors in descriptive and taxonomic works. Two systems of numbering the stages were in use until Gosner (1960) presented a table which simplified them. Johnson (1965) described and illustrated the stages as they applied to the spotted frog, *Rana pretiosa luteiventris*.

Table 10 is a summarization from Gosner (1960) and Johnson (1965), and is used as a standard of comparison since growth rates are too variable from one locality to another to be used for this purpose.

GROWTH RATE. The embryonic growth up through stage 27 (transformation stage from embryo to larvae) is dependent upon food stored in the yolk. All growth beyond this stage is dependent upon the tadpole's own feeding. For this reason no constant measurements of growth were taken until this stage. Those tadpoles which developed at warmer temepratures reached this stage in a shorter period of time and were 2 to 3 mm longer in total length. Study site II, pond B, continually maintained a 4-8 C warmer temperature than pond A until the middle of September when they became equivalent. An average of temperature readings taken at different hours of the day throughout the larval period shows pond A with 13.6 C and pond B with 18.7° C. The more rapid development resulting from the warmer temperature at pond B was, however, counteracted by the crowded conditions imposed upon the tadpoles when a screen, (Fig. 2) was placed around some of the eggs. The effects of the screen were evident by the middle of May when it was obvious that the growth of the tadpoles at pond A exceeded that of the now stunted tadpoles of pond B (Fig. 11). Another factor which may have had an effect upon the growth of the tadpoles at pond B was the high concentration of dissolved salt in the water. The concentration was 622ppm at pond B as compared with a 380 ppm reading at pond A. Pond B also had a pH of 8.9 compared with a 7.7 at pond A. A detailed study of dissolved minerals was not made; however, their effects prove to be very similar to those causing the stunted condition in plants grown in the same concentration of minerals because of the checked absorption of water.

Cameron (1940), in a summary of his work, stated that for *Rana pipiens*:

> 1. The nature and amount of dissolved substances and their relative proportions exert separate and unlike influences upon the rate of development and the stage attained at hatching of normal frog embryos. Eggs kept in well water containing fluorine hatch earlier but at a less advanced stage of development than those kept in pond or distilled water.
>
> 2. Flourine in concentrations as low as 1 ppm is able to exert a constant and measurable retardation on the rate of development and stage at hatching.

The tadpoles of pond B showed their greatest rate of growth from April 10 to May 23. At the end of this time their total length varied within a range of from 33 to 47 mm (Fig. 11). This growth rate was a maximum of approximately 2.7 mm per day and a minimum of 1.5 mm per day since stage 26. The development stage at the end of this growth period varied from 33 to 37 (Fig. 12) indicating that the greatest period of growth was from the first appearance of the hind limb bud until the full development of the hind foot. There was no appreciable growth from May 23 to July 27. The ontogenetic development, however, had advanced to a stage where several of the larger tadpoles were transforming into frogs (Fig. 12). This transformation of larger tadpoles seemed to release some of the growth retarding effects on smaller ones (Fig. 16-21). Thus, there followed another period of increased growth so that by the end of August their total length varied from 40 to 57 mm. Rose (1960) stated that when stunted tadpoles were separated from their larger siblings normal growth again took place.

The tadpoles of pond A continued their growth until stage 40 when metamorphosis began without any noticeable decrease in the growth rate (Fig. 13); therefore, tadpoles at this pond had mostly transformed into immature frogs by the end of August. Although the development of larvae at Pond A was approximately two weeks later than at pond B, they developed at the same rate until the first of June at which time the tadpoles of pond B became stunted (Fig. 12.)

The individual size of each tadpole showed signs of variability shortly before the hatching stage and these differences became more exaggerated with their development. Cameron (1940) suggested that

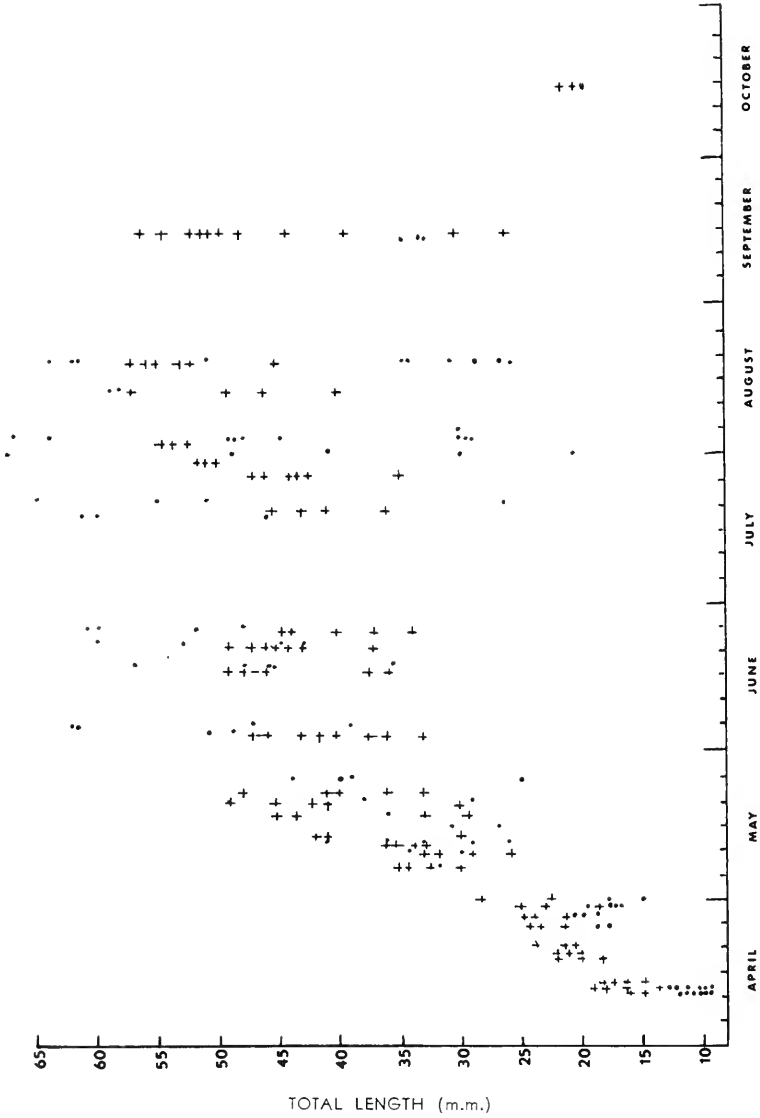

Fig. 11. Scatter diagram showing total length of specimens collected randomly at study area II on days indicated. Dots are pond A and crosses are pond B.

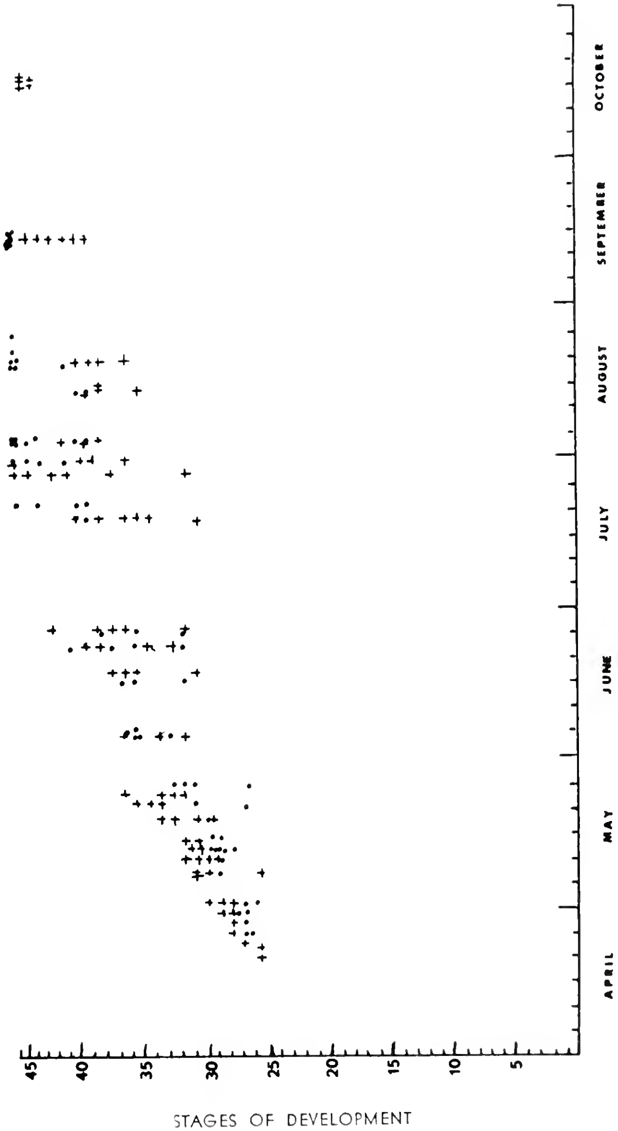

Fig. 12. Scatter diagram showing stages of development of specimens collected randomly at study area II on days indicated. Dots are pond A and crosses pond B.

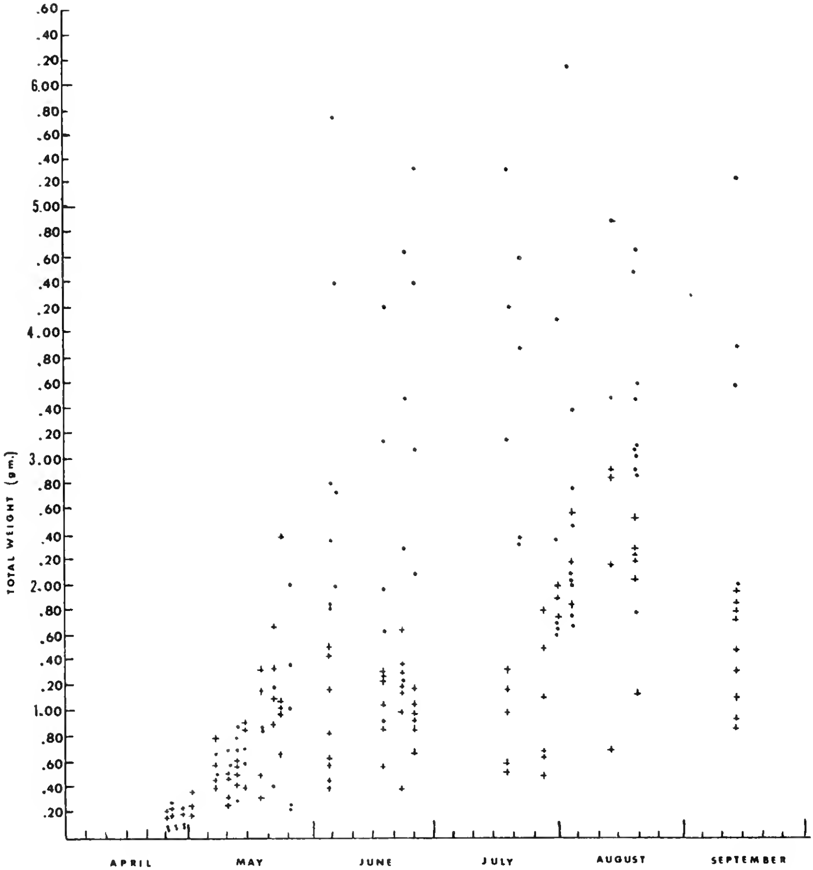

Fig. 13. Scatter diagram showing total weight of specimens collected randomly at study area II on days indicated. Dots are pond A and crosses pond B.

there is a genetic variation of as much as 10 percent in the size of eggs reaching a given stage. This difference in size was more apparent at pond A where the total mass of the individuals, as shown by the weights in Fig. 11, on August 3, had a range of 1.69 to 6.12 gm.

An examination of Figs. 11-13 shows that absolute body dimensions are so variable throughout the larval development that the use of these measurements as key characters in species identification would be most difficult. The use of body ratios as suggested by Limbaugh and Volpe (1957) is also questionable since there is a variance from one individual to another even in those of the same age (Fig. 14). Data show that the larger tadpoles have a smaller tail to head ratio, and when the head length is greater than 24 mm the tail can have a variance of approximately 23 mm (21 to 44 mm) (Fig. 16).

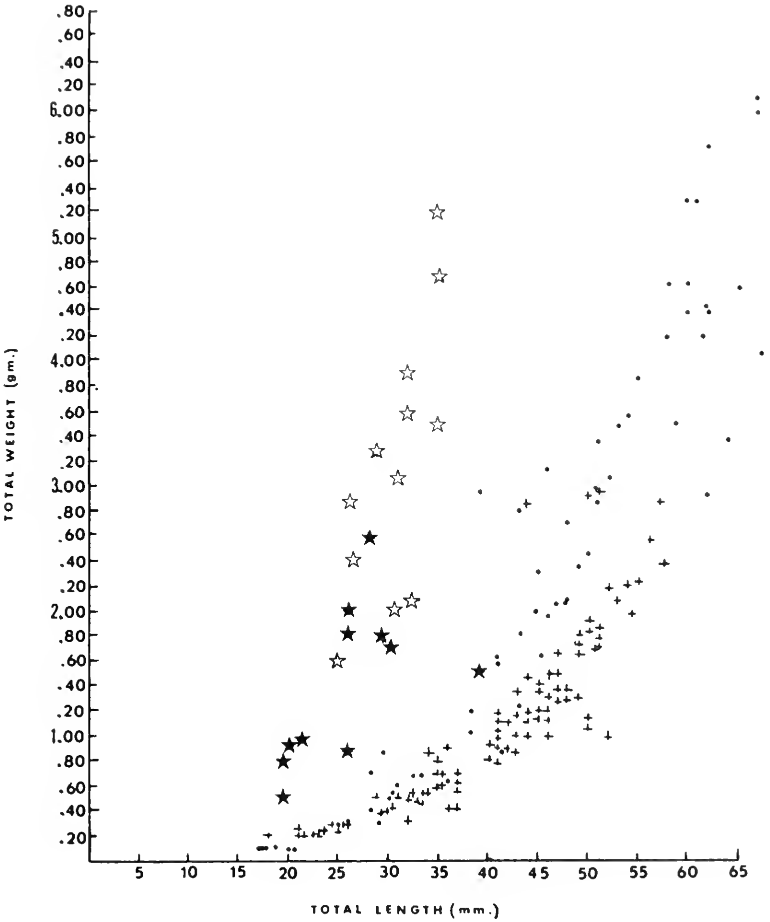

Fig. 14. Scatter diagram showing comparison of length and weights of specimens collected randomly at study area II. Dots indicate specimens up through stage 45 at pond A, crosses indicate specimens up through stage 45 at pond B, open stars indicate specimens past stage 45 at pond A, and closed stars indicate specimens past stage 45 at pond B.

Tadpoles at pond A normally began metamorphosis, stage 41, once they reached a maximum total length of 50-55 mm (Fig. 11, 12 and 15). Some tadpoles, however, continue to grow even after others of approximately equal size have begun transformation, so that they reached a maximum size of up to 70 mm two or three weeks later. There is a tendency for these large tadpoles to remain in an arrested state of development between stages 36 and 40 once they have grown past the normal size for transformation. They remained as large tadpoles up until the last of August before any started to transform and then all were able to complete metamorphosis by September 15, 1966.

The tadpoles at pond B were not only retarded in size (as a group), but also retarded in their ontological development (Fig. 12 and 15). The first transformation was on August 3, 1966, two weeks later than the first tadpoles from pond A (Fig. 12). Transformation was a slow process, requiring until October 15, 1966, for the remainder of the population to complete metamorphosis (Fig. 12). Therefore, the time required for metamorphosis to occur at this locality varied from 122 days to a maximum of 209 days after egg laying.

The maximum and minimum total lengths of tadpoles at pond B reaching stage 40, were 57 to 47 mm respectively (Fig. 15), compared with the same maximum and minimum of 70 and 60 mm at pond A. An examination of Fig. 14 gives another picture of the smallness of transforming frogs from pond B. When comparing their weights with total length, the pond B tadpoles are consistently smaller at the time of metamorphosis, with the smallest weighing 0.52 gm and a total length (snout-vent) of 19.5 mm. This would indicate that in some tadpoles very little growth would have taken place since the middle of May (when the stunted condition developed) because they were approximately the same head-body (snout-vent) length and total weight as the tadpoles on May 23 (Fig. 13). It soon

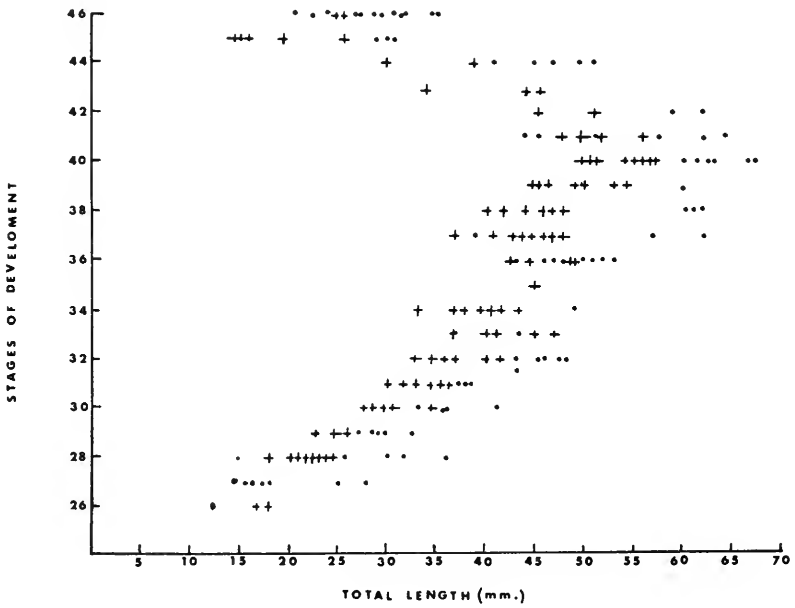

Fig. 15. Scatter diagram showing comparison of total length and stage of development of specimens collected at study area II. Dots indicate pond A and crosses pond B.

becomes apparent that size is not one of the stimulating factors in metamorphosis (Fig. 14), but rather metamorphosis is dependent on an internal reaction.

Once metamorphosis begins (stage 41) the time required to complete the transformation (stage 46) is comparatively short. A series of 10 tadpoles at stage 40 were examined to determine the time required for the appearance of the front legs. The front leg is the first to appear and the joint of the elbow can be seen appearing out of the spircular opening for 3 to 4 hours before the full leg becomes apparent. Only an occasional three legged frog will be observed in nature because of the brevity of this stage. Of the 10 specimens examined after the left leg appeared, the time varied from 4 to 8 hours before the right leg appeared. Detailed descriptions of the tadpoles are given by Stebbins (1951), Skousen (1952), Turner (1958), and Johnson (1965), and it is for this reason that we have not included detailed descriptions.

Hibernation. The ponds at study area II were checked at inervals during the fall of 1966 to determine the data of disappearance for hibernation. Both frogs and tadpoles were seen until the first of October, but by the 15th all of the tadpoles had metamorphosed and were basking at the edge of the pond. The adult frogs were seen in the deeper water among the cattails. The next observation was October 27 at five o'clock p.m. The water temperature at this time was 9° C at pond A and 14° C at pond B; no frogs were evident. The air temperature had been down to freezing for several nights since the last visit, but it had taken about two weeks for the water to cool to or below the critical 10° C level (Fig. 16). The frogs had been observed in about the same location of the pond throughout the sum-

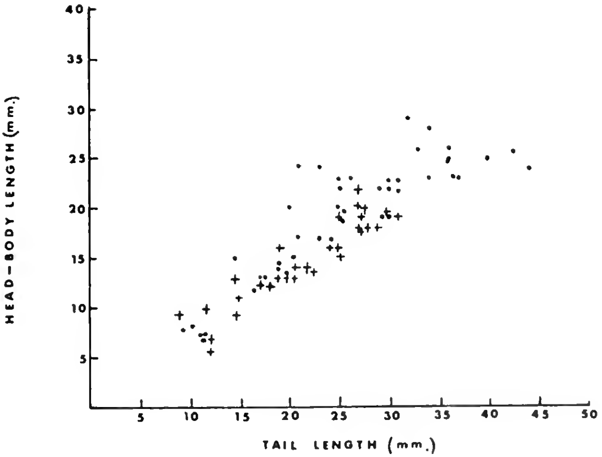

Fig. 16. Scatter diagram showing comparison of tail and head-body lengths up through stage 40 of specimens collected at study area II. Dots are pond A and crosses pond B.

mer and right up until the time of hibernation. It is assumed, therefore, that these frogs hibernate in the muck under the same water in which they breed.

Conclusions and Summary

This study was in progress with some interruptions from 1962 to 1967 for the purpose of investigating the breeding biology and life history of *Rana pretiosa pretiosa* Baird and Girard in central Utah. Some effects of various environmental factors upon the growth and habits of this species were considered.

Collections were made from the time the adults emerged from hibernation in the spring until the tadpoles metamorphosed and frogs hibernated in the fall. Data gathered at the ponds and samples of the life history stages were taken to the laboratory where they were analyzed and studied.

The western spotted frogs emerged from hibernation normally during the middle of March as a result of the warming of the environment. This same species does not emerge until May at Yellowstone National Park, Wyoming (Turner 1958), but is usually present by late February in Washington (Svihla 1935). A few individuals were reported by Dickerson (1906) to be out sunning themselves throughout the winter at Puget Sound.

In Utah this species prefers small ponds of standing water grown thick with stonewart and possessing a deep muck bottom from which cattails emerge. Tanner (1931) in speaking of the Utah population states, "it is always found near springs, small streams, and swamps." Turner (1958) recorded them as visitors of "pools of stagnant water . . . " for egg deposition. Stebbins (1966), however, reported the habitat as follows: "A highly aquatic species found in the vicinity of cold, permanent water—streams, rivers, marshes, springs, pools, and small lakes. Seems not to occur in warm stagnant ponds grown to cattails."

The adult male frogs appear in large numbers at the beginning of the breeding season, which begins immediately following the emergence of the larger females. The emergent male frogs seem to congregate in small areas of the ponds as breeding choruses. The breeding season usually lasts for a short period and all eggs are laid within a week or two depending on prevailing temperatures. The males outnumber the females by a ratio of 5 to 1, thus there is strong competition for a mate. The strong sexual drive in the males may be the result of this strong competition.

The voice of the male is characterized by a low clicking sound which can be reproduced by clicking ones tongue against the top of his mouth. The call is very weak and can normally be heard for only 20-30 feet. The distance compares favorably with that reported by Turner (1958), but is considerably less than the quarter of a mile reported by Svihla (1935). Stebbins (1966) stated that the call was unknown in *Rana pretiosa*.

The eggs are laid shortly after the arrival of females and vary in number from 147 to 1160 per clutch, the average being approximately 750 per clutch. The range of eggs per clutch is lower than the 1100 to 1500 reported by Svihla (1935). It is, however, higher than the 206 to 802 reported by Turner (1958). Turner (1958) reported that his eggs numbers were based upon counts of eggs in clusters 1 to 3 days old; Svihla's (1935) reported that the number is an estimation based upon two egg masses which measured 1500 cc and 1100 cc. His determinations were made as follows: "Since each egg measured more than 1 cc the number of eggs in these masses would approximate 1500 and 1100 respectively." Because these same 1100 and 1500 figures are reported by Livezey and Wright (1947), Wright and Wright (1949), and Stebbins (1951), and on the basis of data gathered for this study, it appears that no actual counts were made by these authors and that their numbers are, at least for the Utah population, too high.

The eggs average 2.5 mm in diameter and are surrounded by a distinct outer gelatinous envelope and an indistinct inner one, averaging 10.0 and 5.0 mm respectively. Following the key prepared by Livezey and Wright (1947), these populations are *R. p. pretiosa.*

The eggs have required from one week to hatch in the laboratory to 13-23 days in nature, the majority hatching about two weeks after oviposition. This two week incubation period is the same as that required by the frogs in Wyoming as reported by Turner (1958), but longer than the four days given by Carl (1943) for those in British Columbia. Johnson (1965) reported the eggs as taking 72 hours to hatch at 25° C but longer at cooler temperatures.

Several factors were noted which affect the frogs' growth and behavior. These were temperature, crowding, and perhaps dissolved minerals in the water.

Temperature has an effect upon all stages of the life history of the frog. The adult activity seems to be affected by temperatures approximately 10-11° C. Temperatures below this point bring on a quiescence in their activities. The eggs are laid at temperatures above 14° C. These temperatures are higher than the 5° C which Middendorf (1957) reported as being critical in the frogs' activity. The eggs and tadpoles are subject to a wide range of temperature but growth is more rapid at the warmer temperatures. Johnson (1965) found 6° and 28° C to be the minimum and maximum temperatures limiting normal embryonic development for this species. Other studies on temperature tolerance and rates of development are by Moore (1938, 1939, and 1942).

A high concentration of soluable salts in the water was suspected of having retarding effects both upon the spring emergence of the adults and the growth of the larvae. Cameron (1940) observed that low concentrations of flourine retarded development. Gosner and Black (1957) studied the effects of acidity on the development and hatching of frogs, while Merwin and Allee (1943) noted the retarding effects of carbon dioxide on the cleavage rates of frog eggs.

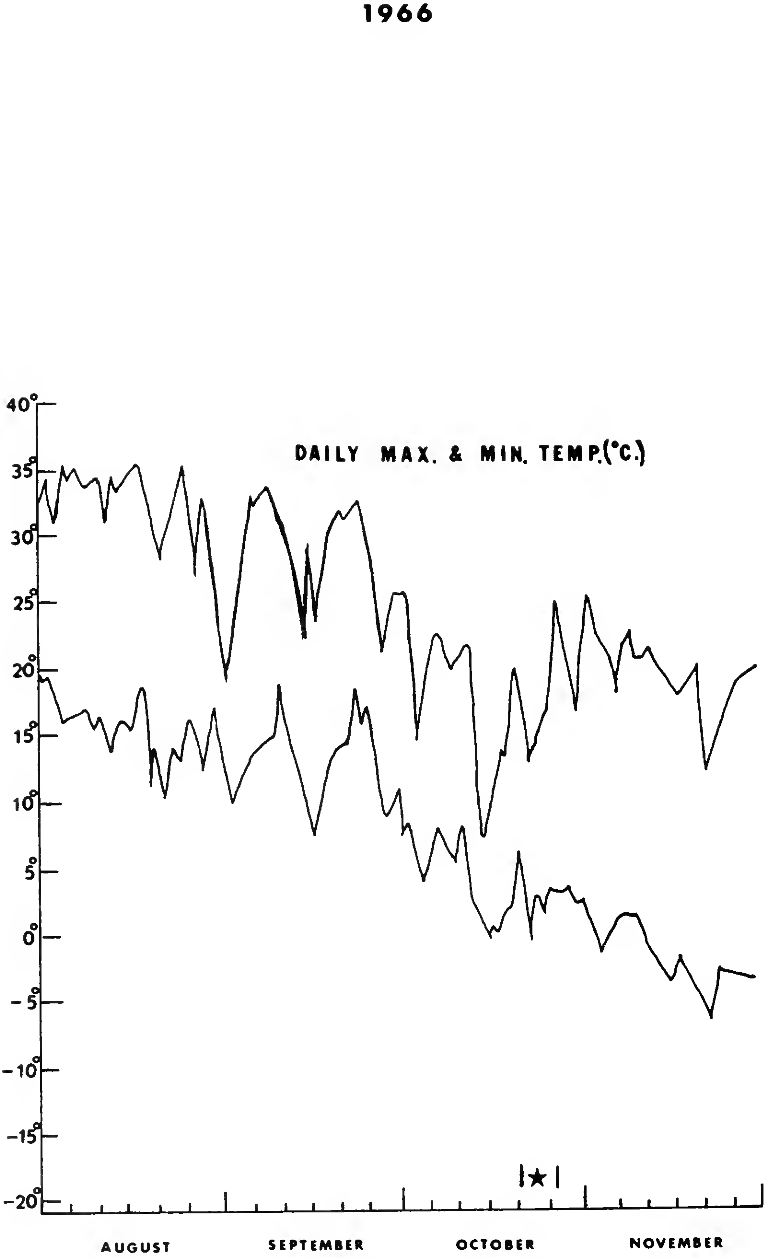

Fig. 17. Air temperature for the fall of 1966. Stars indicate approximate date of hibernation.

Crowding of tadpoles was observed to have a retarding effect upon size and development. This same phenomonon has been observed and studied by Lynn and Edelman (1936), Rose (1960), Adolph (1929), Rugh (1934), and Richards (1958) in other species of Anura.

Metamorphosis was observed to begin on July 27, 1966; this was approximately 122 days following ovulation. Some tadpoles required up to 209 days to transform. It may therefore be concluded that at higher elevations or more northern latitudes having a shorter summer that tadpoles may require more than one summer to complete their growth and to transform as reported by Logier (1932) in British Columbia and Turner (1958) in Wyoming.

An examination of the larval mouth parts reveals a tooth row formula of two rows and three lower rows which according to Svihla (1935) would place them as *R. p. luteiventris*.

Hibernation began during the middle of October approximately two weeks after the first freezing temperatures, and presumably under the same water where their summer atcivities were concentrated.

The adults are variable in key characteristics and normally are classified as *R. p. pretiosa*. The ventral coloration is variable between orange and red. The following color description given by Stebbins (1966) does not fit the Utah population: "Populations in Nevada, Utah, Idaho south of Salmon River, and SE Oregon usually have yellowish ventral color; elsewhere red or salmon predominates."

The Utah *pretiosa* do not completely fit present keys to the subspecies and have been identified in various studies as either *pretiosa* or *luteiventris*. The taxonomic characters examined in this study show an intergradation of sub-specific types. Based upon the eggs and adult coloration we consider the Utah population to be *Rana p. pretiosa*. The susceptibility of the larvae to different water conditions may be the factor which limits the distribution of the subspecies rather than the differences in the adults which seem to be ecologically similar. Wright and Wright (1949) in giving the distribution of the *pretiosa* subspecies state that *luteiventris* occupies the tertiary volcanic areas, whereas *pretiosa* prefer the continental deposit areas. The key to the taxonomy and distribution of this species may very well be the differences in ecological tolerance of the immature frog rather than the adults.

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FOSSIL CHELONIANS, *CHRYSEMYS* AND *CLEMMYS*, FROM THE UPPER PLIOCENE OF IDAHO

G. R. Zug[1]

The extant reptilian fauna of the Columbian Plateau and the northern half of the Basin and Range Province lacks turtles. Their absence appears to be of relatively recent occurrence, for turtles persist in the surrounding areas and have been found in Plio-Pleistocene deposits, Glenn Ferry Formation, of this region. The latest faunal list for the Glenn Ferry Formation (Taylor, 1966, p. 75) includes *Kinosternon sp.* and *Pseudemy idahoensis.* Through the effort of Dr. C. W. Hibbard and his field parties, a large collection of chelonian shell fragments has been amassed from the vicinity of Hagerman, Twin Falls County, Idaho. Unless indicated otherwise, the specimens reported herein are from the Hagerman area.

Family Kinosternidae

Kinosternon Spix

Remarks. There are no elements that can be assigned to this taxon. Unfortunately, it seems that Taylor (1966) misread Hibbard's (1959), p. 11) statement. Hibbard indicated only that the shell fragments may represent "*Kinosternon*, *Chrysemys*, or *Pseudemys*." This error was compounded by the limited distribution of a faunal compilation and as such has appeared elsewhere (Holman, 1968).

Family Testudinidae

Chrysemys idahoensis (Gilmore)

Material. Peripherals, UMMP V45276A, V52778; Hyoplastron, UMMP V53417; Xiphiplastra, UMMP V53417, V54129.

Remarks. Of the two turtles represented in this collection, very few elements can be assigned to *C. idahoensis.* All *Chrysemys* elements were compared with Gilmore's type series and match the morphology therein. A humeropectoral sulcus extends across the entire width of the hyoplastron and distally forms an anterior loop (Gilmore, 1933, Pl. 2). Both xiphiplastra possess a strong step laterally between the femoral and anal scutes and a shallow dorsal groove medial of the scutes. These features are characteristic of *C. idahoensis.*

An anterior half of a plastron (UMMP V42609) has been recovered from the Late Hemphilian Wolf Canyon area of Meade County, Kansas. The humeropectoral sulcus of this plastron forms an anterior loop laterally on each side, indicating that this fossil is also *C. idahoensis.* Thus temporally, *C. idahoensis* extends from approxi-

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[1] United States National Museum, Washington, D.C.

mately 3.5 million BP to about 5 million BP and spatially from south-central Idaho to southwestern Kansas.

In the original description, Gilmore (1933) suggested that the affinities of this species were with the *rubriventris* group and not with *Trachemys*, i.e.. the *scripta* group. The reverse, however, seems to be true. In the *rubriventris* group, the skull characteristically possesses a beak bordered by cusps, a high, serrated, median ridge with a pair of anteromedial cusps on the dorsal alveolar surface, a shallow posteromedial indentation of the dorsal alveolar surface, and a small pro-otic tuberosity. *C. idahoensis* and the *scripta* group have no cusp on the beak, a low, smooth, median ridge with no cusps, a deep posteromedial indentation of the dorsal alveolar surface, and a well developed pro-otic tuberosity. Unlike the skulls of the *rubriventris* or the *scripta* group, the anterior edge of the inferior process of the parietal is buttress-like in *C. idahoensis*, similar to the condition seen in *Malaclemys geographica*. This buttress-like process and the broad alveolar surfaces suggest that this species feed on mollusks.

Clemmys owyheensis Brattstrom and Sturn

Material. Nuchals, UMMP V34444, V49940, V50201. V53128. V53527,V53556, V53731. V53773; Peripherals, UMMP V45276 (2). V49956, V50349 (14), V52778C-E. V53128 (7). V53264 (6). V53445 (7), V53555, V54595 (5).V55477 (2). V55537: Pygals. UMMP V34444 (4). V49558 (2). V50349 (3). V50553 (2). V50938. V51132, V51277, V51737. V53128 (2). V53264. V53731 (2). V54706, V56076 (3), V56261, V56267; Epiplastra. UMMP V34444. V50349 (3), V53264 (2). V53445, V53553 (2). V53755; Endoplastra. UMMP V34444, V50091, V50349. V53128. V53264 (3). V53445 (2). V53731, V53772 (2). V56327; Hyoplastra, UMMP V53128. V53528 (2); Hypoplastra. UMMP V52778. V53264. V53421. V53555; Xiphiplastra, UMMP V53264 (2). V53445 (3). V53553. V53731.

Remarks. Brattstrom and Sturn (1959) described *Clemmys owyheensis* on an endoplastron from a Hemphillian (Middle Pliocene) locality in Oregon. *C. owyheensis* is characterized by each gulahumeral sulcus of the endoplastron forming a 33-degree angle or less with the midline, a prominent anterior knob on the endoplastron, and a humeropectoral sulcus crossing the endoplastron. The last character occurs in both *Terrapene* and *Clemmys*. The endoplastron of *Terrapene* is diamond-shaped and in adult specimens inseparably fused with the epiplastra and hyoplastra. The range of variation of the gulahumeral angle is 24 to 37 degrees for the endoplastra from the Hagerman and 31 to 47 degrees for nuchals from seven extant *C. marmorata*. Some recent *C. marmorata* possess prominent anterior knobs on the endoplastra. Thus on the basis of endoplastral characters, the fossil *Clemmys* from the Pliocene cannot be separated from the extant *C. marmorata*. However, the variation in the morphology of the other shell elements from Hagerman, Idaho, suggests that the fossil remains represent a distinct population. Since the Hagerman endoplastra match the diagnosis of Brattstrom and Sturn, *Clemmys owyheensis* is recognized, at least until more material is available, as a distinct species. The conspecificity of the Hagerman fossil *Clemmys* and *C. owyheensis* is strengthened by their occurrence in the same drainage system, the Idaho Lake system. Temporally, these two *Clemmys* may be separated by as much as 5.5 million years.

The nuchals of *C. owyheensis* differ from those of *Malaclemys* and the *Chrysemys floridana* group by an extensive nuchal scute underlay and from all *Chrysemys* by a proportionately narrower nuchal scute. The *Clemmys* nuchal can be distinguished from that of *Emydoidea*, because in the latter the anterolateral border of the first vertebral scute is rarely impressed on the bone. If the sulcus of vertebral scute is present, it lies completely posterior to the greatest width of the bone. In *Terrapene*, the anterolateral tips of the first vertebral scute do not extend beyond the margin of the nuchal bone. The fossil nuchals fall into the range of variation seen in *Clemmys*, but cannot be assigned to any particular extant species. Dorsally the fossil nuchals match the appearance of those of *C. guttata* and *marmorata* with the anterolateral corners of the first vertebral scute extending off the nuchal onto the first peripheral. In *C. insculpta*, these corners do not approach the edge of the nuchal closely, whereas the corners in *C. muhlenbergi* end at the edge as in *Terrapene*. Ventrally the nuchals of *C. owyheensis* possess a long nuchal scute underlay as in *C. insculpta* and *guttata*.

The pygals of *C. owyheensis* are bifurcate posteriorly and have posteriorly converging lateral sides. Only *C. m. marmorata* possesses this condition; all other *Clemmys* have only a shallow nick. In *Chrysemys*, pygals with deep notches have parallel or posteriorly diverging sides.

The epiplastra from Hagerman have the deep gular overlay and thick gular lip characteristic of *Clemmys*. The anterior edge of the gular lip is smooth and bordered laterally by a distinct horn on each side. Likewise, the fossil hyoplastra are from *Clemmys*, for they have an anterior humeropectoral sulcus. On the hypoplastra of *C. owyheensis*, the abdominomarginal sulcus coincides with the hypoplastroperipheral suture, and a deep groove extends posteriorly from the inguinal buttress along the abdominal and femoral scutes onto the xiphiplastron. The condition of the hypoplastron is commonly observed in *Clemmys*. Each xiphiplastron also possesses a deep dorsal groove, and in addition the transition laterally between anal and femoral scutes is smooth, i.e., no step is formed.

Discussion and Summary

The Hagerman chelonian fauna consists of two species, *Chrysemys idahoensis* and *Clemmys owyheensis*. No turtles occur in this region today, although Stebbins (1954,192) lists an unconfirmed report of a *C. marmorata* from Eagles Nest, Idaho, which is upstream of the Hagerman locality. If this record is excluded, the closest

Clemmys population is *C. marmorata* in the Truckee and Carson rivers of Nevada. It has been suggested that the Nevada population is introduced; however, two factors hint that it may be a natural population. Although *C. owyheensis* shares some characteristics with the eastern species of *Clemmys*, it appears to be closely related to *C. marmorata*. Furthermore, the absence of inguinal scutes on the fossil hypoplastra indicates that the Hagerman *Clemmys* are related to the southern race of *C. marmorata*. Other aquatic animals, mollusks (Taylor, 1966) and fish (Miller, 1965), show this relationship between faunas of southern Idaho and central California. This has led to the postulation of a different drainage pattern for the Snake River during the Pliocene and most of the Pleistocene. The course of the river was from southeastern Oregon across northwestern Nevada to central California. Thus the Nevada population of *C. marmorata* may be a relict as its present distribution coincides with this old drainage pattern.

The shell elements of the Hagerman turtles were obtained from several localities representing a temporal span of about 100,000 years (Fig. 1). *Clemmys* occur throughout this entire temporal span. In contrast, unquestionable remains of *Chrysemys* are clustered around the Horse Quarry (Fig. 1). This is a strange occurrence, for the buttress-like inferior parietal process and broad alveolar surfaces of *C. idahoensis* indicate that this taxon was molluscivorous. Taylor (1966) reported the near absence of mollusks from this stratigraphic position. Accordingly, if *C. idahoensis* were entirely molluscivorous as has been suggested for the minnow, *Mylocyprinus* (Uyeno, 1961), it should also be absent from the Lake Idaho fauna of that time and would be expected to occur earlier in assocation with the abundant mollusk fauna.

At the present, *C. idahoensis* has been found in Kansas and Idaho. This distribution is not matched by either of its suggested relatives, *rubriventris* (Gilmore, 1933) or *scripta*. The geographic proximity of *C. scripta* attests to the likelihood of *C. idahoensis* being a derivative of the *scripta* lineage rather than the Atlantic coastal plain *rubriventris*. The cranial characteristics of *C. idahoensis* also seem to be more similar to *scripta* than *rubriventris*.

ACKNOWLEDGMENTS

The collection of fossil turtles from Hagerman, Idaho, was made by Dr. Hibbard and his students, who were supported by a grant from the National Science Foundation, GB-1528. I wish to thank Dr. C. W. Hibbard, University of Michigan Museum of Paleontology (UMMP), for the opportunity to examine the Hagerman material. Dr. N. Hotton, United States National Museum (USNM), permitted me to examine the types of *C. idahoensis*. Skeletons of the extant species of *Clemmys* were examined through the courtesy of Dr. C. F. Walker, University of Michigan Museum of Zoology. Drs. C. W. Hibbard and J. A. Peters have improved the manuscript

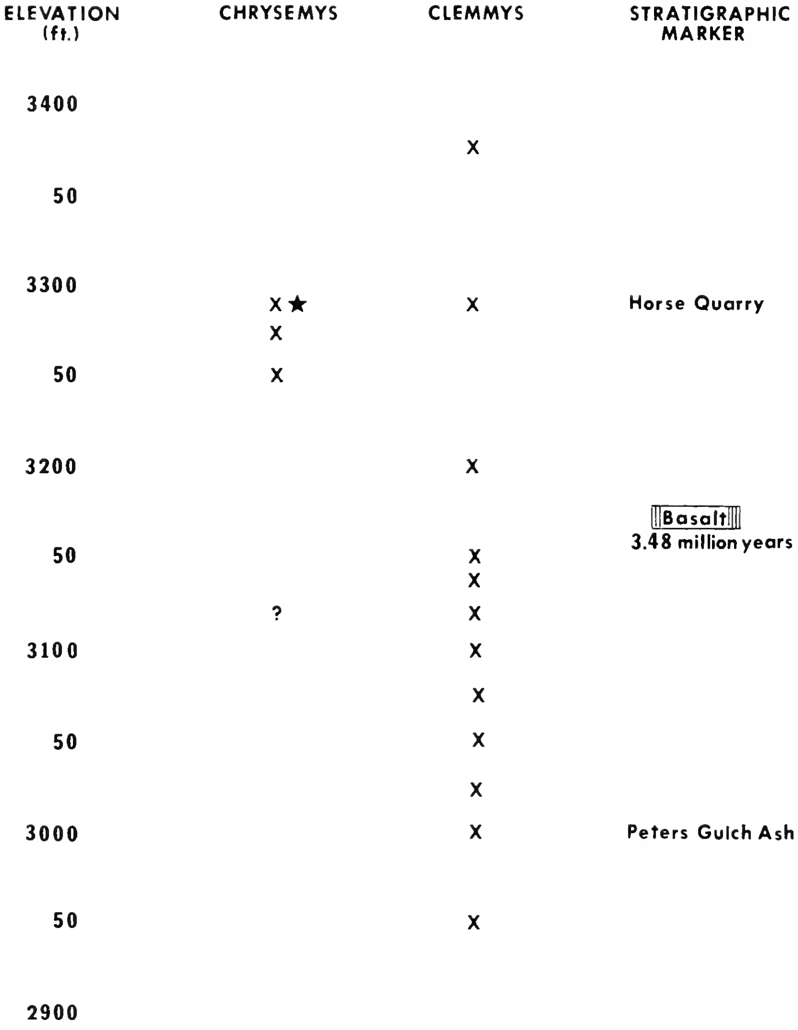

Figure 1. The stratigraphic distribution of *Chrysemys idahoensis* and *Clemmys owyheensis* in the vicinity of Hagerman, Idaho. The elevation is the height of fossiliferous strata above sea level. X, specimen(s) in the University of Michigan Museum of Paleontology; star, the type specimens of *C. idahoensis* (USNM 12059-60).

by their editorial comments. Dr. P. Bjork greatly aided the preparation of the figure.

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NOTES ON THE DISTRIBUTION AND BIONOMICS OF SOME IDAHO CERAMBYCIDAE (COLEOPTERA)[1]

William F. Barr and Richard L. Penrose[2]

Distributional and bionomical information concerning some species of Idaho Cerambycidae, especially those associated with rangeland shrubs, has been accumulated over the past several years primarily during the course of field studies. Although fragmentary in scope, the more pertinent of this information is presented at this time for use by other workers. Representatives of each species treated in this paper are deposited in the University of Idaho insect collections.

Thanks is given to J. A. Chemsak and E. G. Linsley, University of California, and J. N. Knull, Ohio State University, for their assistance in the determination of some specimens.

Ammanus vittigera LeConte

Linsley (1962) recorded the known northern limits of the distributional range of this southwestern species as southern Utah. Two specimens have been taken in southwestern Idaho. One was associated with a stand of *Atriplex canescens* (Pursh) Nutt. four miles southeast of Grandview, Owyhee County, June 20, 1959 (W. F. Barr), and the other was collected from the foliage of *A. confertifolia* (Torr. & Frem.) Wats. eight miles northwest of Walters Ferry, Canyon County, June 15, 1961 (J. E. Henry).

Asemum caseyi Linsley

This species known previously from the Pacific Coast region is recorded from Idaho for the first time on the basis of specimens collected at Hot Springs, nine miles north of Mountain Home, Elmore County, June 16, 1957 (W. F. Barr) and Pollock, Idaho County, June 7, 1956 (R. W. Portman).

Asemum nitidum LeConte

This common Pacific Coast species has not been recorded previously from Idaho. Collection records from the state are: Craters of the Moon National Monument, Butte County, July 15, 1964 (D.S. Horning, Jr.), on *Pinus flexilis* James, Moscow, Latah County, August 28, 1954 (W. F. Barr); and Troy, Latah County, August 30, 1954 (R. H. Abbott).

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[1] Published with the approval of the Director of the Agricultural Experiment Station as research paper no. 746.

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Atimia dorsalis LeConte

A specimen from Wallace, July 9, 1925 (O. Heullemann) and a specimen labeled "west central Idaho" collected by W. E. Ferguson in June 1963 represent new distributional records for the state.

Crossidius ater LeConte

Although this species has been reported from Idaho (Linsley and Chemsak, 1961), its known distributional range within the state now can be expanded. New collection sites are: six miles south of Hailey, Blaine County, August 7, 1966 (M. A. Brusven); three miles north and three miles northwest of Malta, Cassia County, September 12, 1965 (E. J. Allen, W. F. Barr, R. L. Penrose); Craters of the Moon National Monument, Butte County, September 6, 1964 (D. S. Horning, Jr.); 1.5 miles west of Dayton, Franklin County, September 13, 1965 (W. F. Barr); 1.5 miles northeast of Baker, Lemhi County, September 2, 1965 (R. L. Westcott); Haynes Creek, 4.5 miles north of Tendoy, Lemhi County, August 28, 1962 (W. F. Barr); 19 miles north of Shoshone, Lincoln County, September 2, 1965 (R. L. Westcott); and 10 miles southwest of Midvale, Washington County, September 12, 1948 (W. F. Barr).

Adults have been taken on flowers of *Chrysothamnus nauseosus* (Pall.) Britt., *C. viscidiflorus typicus* (Hall & Clem.) Cron., *C. v. latifolius* (D. C. Eat.) Rydb., *C. v. lanceolatus* Nutt. and *Gutierrizia sarothrae* (Pursh) Britt. and Rusby in the state. In the Malta area larvae and a teneral adult have been found in the roots of *Artemisia tridentata* Nutt.

Crossidius discoideus blandi Casey

Idaho collection records of adults, pupae, and larvae are available for this subspecies indicating that it ranges into the more southeasterly portions of the state. Collection sites are: two miles north of Swan Lake, Bannock County, July 25, 1967 (R. L. Penrose) (larvae and pupae); one mile east of Basin, Cassia County, June 15, 1967 (W. F. Barr, S. M. Hogue, R. L. Penrose) (larvae); three miles northwest of Malta, Cassia County, September 11 and 12, 1965 (E. J. Allen, W. F. Barr, R. L. Penrose) (adults); 2.5 miles north of Dayton, Franklin County, September 13, 1965 (W. F. Barr, R. L. Penrose) (adults); Register Rocks, Power County, January 28, 1967 (R. L.Penrose) (Larvae); 9.1 miles south of Rockland, Power County, July 25, 1967 (R. L. Penrose) (larvae and pupae). Adults have been found mainly on the flowers of *Gutierrezia sarothrae* (Pursh) Britt. and Rusby and occasionally on the flowers of *Chrysothamnus viscidiflorus* (Hook.) Nutt. Larvae and pupae have been found only in the roots of *G. sarothrae*. Examination of this plant where it occurs in southwestern and central Idaho has thus far failed to disclose the presence of *C. d. blandi*.

Crossidius pulchellus LeConte

The occurrence of this species in Idaho is based on a collection record from Riverdale, Franklin County (Linsley and Chemsak, 1961). Additional collections have been made from three miles west of Dayton, Franklin County, September 13, 1965 (R. L. Penrose); 2.5 miles north of Dayton, Franklin County, September 13, 1965 (W. F. Barr); and Bannock Pass, Lemhi County, August 30, 1962 (W. F. Barr). Adults were taken on the flowers of *Chrysothamnus viscidiflorus* (Hook.) Nutt., *C. nauseosus* (Pall.) Britt., and *Gutierrezia sarothrae* (Pursh) Britt. and Rusby.

Elatotrypes hoferi Fisher

Two small series of specimens were reared from dead wood of *Pinus flexilis* James at the Craters of the Moon National Monument, Butte County, Idaho, by D. S. Horning, Jr., during the summers of 1964 and 1965. These collections establish the occurrence of this species in the state for the first time.

Evodinus vancouveri Casey

This species, not previously recorded from the state, has been collected only at one northern Idaho location. Specimens were taken at Laird Park, Latah County, May 14, 1962 (W. F. Barr and S. D. Smith) and May 20, 1967 (R. L. Westcott). In both instances adults were found on the flowers of *Trillium ovatum* Pursh growing in a dense or partially open coniferous forest comprised mostly of *Abies grandis* Lindl., *Pseudotseuga menzesii* (Murb.) Franco, and *Pinus monticola* Dougl.

Mecas bicallosa Martin

This species is widely distributed in southern Idaho. It has been taken in several different habitats present in foothill areas, in mountain valleys, on a mountain pass, and on the Snake River Plains at elevations that range from approximately 3100 feet to 8752 feet. Collection records include: Galena Summit, Blaine County, July 22, 1961 (W. F. Barr, R. B. Hawkes), July 30, 1967 (S. M. Hogue); 5.5 miles southwest of Almo, Cassia County, June 11, 1962 (W. F. Barr); Bear Creek Camp, Custer County, July 21, 1964 (R. L. Westcott); Bonanza, Custer County, July 22, 1965 (W. F. Barr); Weston Canyon, Franklin County, July 11, 1964 (O. O. Fillmore); six miles southwest of Sweet, Gem County, June 19, 1959 (J. E. Henry); ten miles northeast of Richfield, Lincoln County, June 25, 1959 (W. F. Barr); three miles south of Driggs, Teton County, July 11, 1965 (O. O. Fillmore); and nine miles southwest of Rogerson, Twin Falls County, June 18, 1961 (W. F. Barr). These collections have been associated with *Artemisia tridentata* Nutt., *A. t.* var *vesseyena* (Rydb.), *A. tripartita* Rydb. and *A. arbuscula* Nutt.

Megacheuma brevipennis (LeConte)

This attractive species is known to have a rather broad but discontinuous distributional range in the western United States. However, it appears to occur most abundantly in the more northern portions of the Great Basin and adjoining areas.

The host plants of this species in Idaho have been established as *Sarcobatus vermiculatus* (Hook.) Torr., *Atriplex nuttallii* S. Wats., and *A. confertifolia* (Torr.) Wats. However, this cerambycid has not been found throughout the distributional ranges of these host plants in the state. Collection records are as follows: three miles east of Howe, Butte County, June 22, 1966 (W. F. Barr) (larvae in *A. nuttallii*), August 7, 1955 (W. F. Barr) (adult in pupal cell in *A. nuttallii*); ten miles north of Howe, Butte County, April 11, 1958 (W. F. Barr) (larvae in *A. nuttallii*), June 22, 1967 (W. F. Barr) (larvae in *A. confertifolia*), August 20, 1966 (R. L. Penrose) larvae in *A. nuttallii*), August 31, 1960 (J. E. Henry) (adults); 18 miles northeast of Howe, Butte County, June 14, 1955 (W. F. Barr) (larvae in *A. nuttallii*), July 14, 1956 (W. F. Barr) (pupae in *A. nuttalli*); five miles north of Malta, Cassia County, July 23, 1957 (R. A. Mackie) (adults); six miles southeast of Malta, Cassia County, May 31, 1958 (W. F. Barr) (larvae and pupae in *S. vermiculatus*), September 6 and 15, 1955 (W. F. Barr and R. A. Mackie) (adults); seven miles southeast of Malta, Cassia County, April 30, 1954 (W. F. Barr) (larvae in *A. nuttallii*); four miles east of Idahome, Cassia County, June 1, 1958 (W. F. Barr) (larvae and pupae in *S. vermiculatus*), August 9, 1955 (W. F. Barr) (larvae and adults in *S. vermiculatus*); five miles northwest of Oakley, Cassia County, June 2, 1958 (W. F. Barr) (larvae in *A. confertifolia*), August 16, 1957 (W. F. Barr) (larvae and adults in *A. nuttallii*), October 15, 1956 (W. F. Barr) (larvae in *A. confertifolia*); six miles south of Challis, Custer County, September 17, 1965 (W. F. Barr and R. L. Penrose) (larvae in *A. confertifolia*); 12 miles west of Mountain Home, Elmore County, April 15 and August 11, 1953 (W. F. Barr) (larvae in *A. nuttallii*), June 16 and November 16, 1955 (W. F. Barr) (larvae in *A. nuttallii*); 12 miles northwest of Terreton, Jefferson County, July 14, 1956 (W. F. Barr) (larvae and pupae in *A. nuttallii*), August 30, 1962 (W. F. Barr) (adults); 20 miles northwest of Terreton, Jefferson County, March 27, 1967 (W. F. Barr) (larvae in *A. confertifolia*); one mile north of Murphy, Owyhee County, March 25, 1955 (W. F. Barr) (larvae in *S. vermiculatus*); nine miles northwest of Grandview, Owyhee County, May 27, 1958 (W. F. Barr) (larvae in *A. nuttallii*), August 10, 1953 (W. F. Barr) (larvae and pupae in *A. nuttallii*), August 21, 1966 (E. J. Allen) (adults), September 14, 1955 (W. F. Barr and A. R. Gittins) (adults).

Observations and rearings indicate that the larva of the clerid beetle, *Enoclerus acerbus* Wolcott, preys on larvae and pupae of *M. brevipennis* in the roots of the three host plant species.

Megacyllene robinae (Forst.)

This well-known species apparently has become established in several areas of southern Idaho. Collection records are available from Pocatello, Bannock County, September 28 and October 4, 1965; Gooding, Gooding County, in mid-September (E. Koster); and Idaho Falls, Bonneville County, October 16, 1967. It has also been taken at Spokane, Washington, August 5, 1963 (S. M. Hogue) where it was found on apple wood.

Meriellum proteus (Kirby)

The expected occurrence of this species in the state is confirmed by a single specimen from Moscow Mountain, Latah County, August 1, 1953 (R. H. Abbott).

Monochamus notatus morgani Hopping

A single Idaho collection record is now available for this subspecies from Elk River, Clearwater County, August 30, 1963 (R. Hoff). An adjacent state record is Swan Lake, Lake County, Montana, July 18, 1963 (M. M. Furniss) on *Pinus monticola* Dougl.

Neoclytus balteatus LeConte

This species has been taken at three widely separated localities in southern Idaho. They are: Juniper Mountain, Owyhee County, August 15, 1963 (M. M. Furniss); Smith Prairie, Elmore County, August 14, 1963 (R. E. Miller); and St. Anthony, Fremont County, July 25, 1963 (R. E. Miller). The altitudinal range of these locations is from 4700 feet to 6800 feet.

It may be of interest to note that no species of *Ceanothus*, the recorded host plant genus of *N. balteatus*, occurs in the St. Anthony area, thus suggesting a broader host range than is presently known for this cerambycid.

Prionus (*Homaesthesis*) *integer* LeConte

This species has been recorded previously from southcentral and southeastern Idaho (Linsley, 1962). A collection from Parma, Canyon County, July 10, 1953, now establishes its distributional range across the southern portion of the state. A specimen from Moscow, Latah County, September 30, 1931, in northern Idaho must be regarded as suspected mislabeling.

Adults of *P. integer* are most commonly taken at lights. Larvae have been associated with the roots of *Artemisia tridentata* Nutt. and *Chrysothamnus viscidiflorus* (Hook.) Nutt. On one occasion larvae were found damaging newly planted bean seeds in a field near Burley, Cassia County, and in another instance, cutting underground stems of potato plants in a field near American Falls, Power County. In both cases the fields had been recently cleared for cultivation.

Rosalia funebris Motschusky

This attractive species, previously unreported from Idaho, is uncommon but widely distributed in the state. It has been collected at Rocky Point, Benewah County, July 25, 1964 (R. W. Portman); Sandpoint, Bonner County, July 26, 1932 (W. Virgin); Moscow, Latah County, September 5, 1965 (H. C. Manis), August 1951 (W. F. Barr), June 1950 (H. C. Manis), June 23, 1961 (C. M. Ott), July 28, 1961 (H. C. Manis); Culdesac, Nez Perce County, July 28, 1934 (C. Wakeland); and Twin Falls, Twin Falls County, July 24, 1960 (R. L. Williamson) and August 18, 1953 (A. R. Gittins).

Specimens from Twin Falls have been reared from the wood of box elder *Acer negundo* Linn. and some specimens from Moscow are labeled "apple."

Semanotus juniperi (Fisher)

A significant extension of the distributional range of *S. juniperi* is based on a collection from the west slope of Black Pine Mountains, Cassia County, Idaho, June 10, 1954 (W. F. Barr). A single specimen was dug from the wood of *Juniperus osteosperma* (Torr.) Little. This species was reported by Linsley (1964) as occuring in the "mountains of southern Arizona."

Semanotus ligneus amplus (Casey)

Specimens from northern Idaho localities can be referred to either *S. l. amplus* or *S. l. basalis* (Casey) on the basis of elytral markings. The known host plants of the former subspecies do not occur in this area whereas the host of the latter subspecies does. From the standpoint of distribution as given by Linsley (1964), these Idaho collections would best constitute an extension of the range of *S. l. amplus*.

Because of the distinct possibility of these two forms being synonymous it is perhaps best to consider the Idaho material as *S. l. amplus*. The collection records are: seven miles east of Laird Park, Latah County, April 17, 1962 (S. D. Smith); Moscow Mountain, Latah County, May 10, 1957 (G. N. Knopf); and St. Joe River, Shoshone County, May 21, 1941 (O. Huellemann).

Semanotus ligneus conformis (Casey)

Dead specimens assignable to this subspecies were dug from dead wood of *Juniperus osteosperma* (Torr.) Little five miles southwest of Oakley, Cassia County, June 15, 1967 (R. L. Penrose). Its occurrence in Idaho is not unexpected, inasmuch as Linsley (1964) recorded this subspecies from northern Utah.

Toxotus obtusus LeConte

This dimorphic species is known from several states and Canadian provinces of the Pacific Northwest and northern Rocky Mountains (Hopping, 1937), but has not been recorded from Idaho. Present records for the state include: Targhee Pass, Fremont County, July 15, 1965 (R. L. Westcott); two miles southwest of Bannock Pass, Lemhi County, July 23, 1965 (R. L. Westcott); and two miles south of Troy, Latah County, June 11, 1965 (A. P. Gupta). The Bannock Pass specimens were found crawling on the soil surface and on the stems of *Lupinus* sp.

Typocerus balteatus Horn

In Idaho this species appears to be confined to the broad areas of the southcentral and southeastern portions of the state at elevations ranging from 4800 to 6000 feet. Collections have been made at Elba-Basin Pass, Cassia County, August 23, 1958 (W. F. Barr), August 25, 1959 (J. E. Henry) and September 10, 1965 (W. F. Barr and R. L. Penrose); five miles southwest of St. Anthony, Fremont County, September 6, 1967 (W. F. Barr and J. M. Gillespie) and September 14, 1965 (W. F. Barr); four miles east of Menan, Jefferson County, August 31, 1965 (R. L. Westcott); Register Rocks, Power County, August 15, 1966 (R. L. Penrose); three miles west of Tetonia, Teton County, August 11, 1966 (L. S. Hawkins); Rock Creek Ranger Station, Twin Falls County, July 8, 1965; and Rogerson, Twin Falls County, September 8, 1955 (R. A. Mackie). Most specimens were taken on the flowers of *Chrysothamnus viscidiflorus* (Hook.) Nutt. and a few on the flowers of *C. nauseosus* (Pall.) Britt.

A specimen from the Tetonia collection exhibits a considerable reduction in elytra markings. The subbasal fascia is reduced to a pair of small discal spots, the median fascia to a pair of transverse spots, and the post median fascia is absent. Other specimens from this collection exhibit a tendency towards this extreme condition.

Ulochaetes leoninus LeConte

The occurrence of this distinctive species in Idaho is based on several collections from the following localities in the northern part of the state: Flat Creek, Latah County, June 1952 (T. F. McGill); south slope of Moscow Mountain, Latah County, August 22, 1964 (R. L. Westcott); and Troy, Latah County, August 6 and September 8, 1954 (R. H. Abbott). Linsley (1940) recorded it previously from British Columbia, Washington, Oregon, California and Nevada.

Xylotrechus mormonus (LeConte)

Only four specimens of this northern species are in the University of Idaho collection. They were collected at the Craters of the Moon National Monument, Butte County, July 11, 1964 (D. S. Horning); Basin, Cassia County, June 14, 1953 (P. Ashlock); Murphy Hot Springs, Owyhee County, June 20, 1965 (W. F. Barr); and Donnelly, Valley County, July 18, 1961 (W. F. Barr). No host information is available for these Idaho specimens which constitute the first records for the state.

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OVERWINTERING PHYTOSEIID MITES IN CENTRAL UTAH APPLE ORCHARDS[1]

John W. Leetham and Clive D. Jorgensen[2]

Predaceous typhlodromids[3] have been observed overwintering as adult females in fruit trees of northern temperate regions, but specific studies have been rather limited and no taxonomic or ecologic studies have been reported from Utah. Gilliatt (1935) and Garman and Townsend (1938) suggested that some adult phytoseiids overwintered under the bark of trees while others may seek shelter on the ground. Gilliatt (1935) further reported that adult *Seiulus pomi* Parrott (since divided into a number of *Typhlodromus* spp.) overwintered on twigs in Nova Scotia, concealed in such places as under rough bark, in old bud moth hibernacula, and in deserted oystershell scales (*Lepidosaphes ulmi* Linn.). Herbert (1953) found females of several species overwintering under bark scales of tree trunks and larger branches, in the empty hibernacula of eye-spotted bud moths (*Spilonota ocellana* D. and S.), in empty oystershell scales, and in empty codling moth (*Carpocapsa pomonella* Linn.) cocoons. Chant (1959) found *Typhlodromus bakeri* (Garman) overwintering in deep crevices around scars and wounds and in the splintered ends of dying twigs. Burrell and McCormick (1964) reported three species (*Typhlodromus longipilus* Nesbitt, *Typhlodromus rhenanus* (Oudemans), and *Typhlodromus occidentalis* Nesbitt) hibernating under loose bark of lower tree trunks and in debris around the bases of trees.

In a study of the overwintering sites in Ontario peach orchards large numbers of mites (mostly *T. rhenanus*) were found in bark crevices and deep protected cracks of cankers (Putman, 1959). Some were found in the splintered ends of broken or pruned branches, but none were found in superficially rough areas of living bark on the smaller limbs. Very few were found on twigs that were free of old Lecanium scales although large numbers were taken from twigs possessing old scales.

Only one investigation of the movement of mites from leaves to overwintering sites has been reported (Chant, 1959). He found no mites on leaves that had yellowed, but reported increases in the populations of *Typhlodromus finlandicus* Oudemans, *Typhlodromus tiliae* Oudemans (= *pyri* Scheuten of Chant, 1959), and *Typhlodromus umbricatus* Chant on the green leaves and twigs. Since mites were not found in the soil and cover, he concluded that they abandon

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[1] This study was supported, in part, by grant no. 12-14-100-3029 (33) from the U.S. Department of Agriculture to Brigham Young University, and was completed by the senior author in partial fulfillment of the requirements for a Master of Science degree at Brigham Young University.

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[3] The nomenclature proposed by Chant (1965) was adopted for this study.

the yellowing leaves and move to the branches and trunk to overwinter.

Mortality rates of overwintering phytoseiids have been investigated only incidentally. Anderson and Morgan (1958) reported high winter mortality rates for several unidentified species of phytoseiids in British Columbia. Their calculations were made by comparing mite numbers on leaves in the fall and spring, the difference being attributed to winter mortality. Using similar methods, Chant (1959) found more than 90% mortality in overwintering *T. tiliae* in England. Putman (1959) found mortality of *Amblyseius fallacis* (Garman) in Ontario peach orchards to be "very high."

The purposes of this study were to identify the species of phytoseiids overwintering as adults in central Utah orchards, to determine their overwintering sites, and estimate winter mortality rates and fall movements of *Typhlodromus mcgregori* Chant and *T. occidentalis*—both of which are abundant in Utah apple orchards (Lee and Davis, 1968).

METHODS

This study was made during three consecutive winters, 1965-1968, in Utah County, Utah. Eleven derelict apple orchards (Jorgensen, 1967) located throughout Utah County were qualitatively sampled during the first winter to determine the species of mites overwintering as adults and to locate their overwintering sites. Soil, ground cover, twigs and spurs, and bark were sampled extensively from each orchard. Berlese funnels were used to isolate mites from the collected materials. Occasional samples of crotch refuse, abandoned bird nests, and mummified fruit still clinging to the trees were collected. Twig-spur and bark samples were also collected from derelict orchards of other tree fruit varieties. Frequency charts were then developed to determine the primary overwintering sites of the most prevalent phytoseiid species.

Movements of *T. mcgregori* and *T. occidentalis* from leaves to their respective overwintering sites were investigated during October and November, 1967. Two apple orchards were used; a commercial orchard in Orem, Utah for *T. occidentalis*, and a derelict orchard north of American Fork, Utah for *T. mcgregori*. Samples of 500 leaves were taken from five selected trees in each orchard once a week. Samples of leaves falling from each tree were also taken to check for mites falling to the ground with the leaves. Collections of falling leaves were made by placing a drop cloth beneath the trees and gently shaking the branches to dislodge the leaves. These data were analyzed with a *t*-test to determine whether or not the mean numbers of mites on dropping leaves were significantly smaller than the numbers found on green leaves still adhering to the trees. Incidental collections of twig-spurs and bark were also taken from the commercial orchard in Orem.

The specific location of overwintering sites was investigated during the winters of 1966 to 1968. In 1966, about 300 twigs and spurs from a derelict orchard in Mapleton, Utah were dissected to determine the specific overwintering sites of phytoseiids. Five samples of 500 twig-spurs were collected during the winters of 1966-67 and 1967-68 and each twig cut into three sections based on years of growth as shown in Fig. 1. A year's growth was defined as the distance between two sets of terminal bud scars. Surface areas for the three terminal sections were estimated from 25 arbitrarily selected twig sections from each of the samples. The data were analyzed with an analysis of variance (Ostle, 1963) to check for significant variation in the number of mites among the sections.

A study was attempted to determine the winter mortality rates of *T. mcgregori*. The orchard (102 trees) was divided into five nearly equal size blocks, and five trees randomly selected within each block. One hundred twigs were taken from each tree once each month for five months (December-April, 1967-68). The data were than analyzed with an analysis of variance (Ostle, 1963) to detect possible variations among the months.

Results

Nine species of physoseiids were found overwintering in central Utah apple orchards. *Amblyseius cucumeris* Oudemans, *T. mcgregori*, and *T. occidentalis* were the most numerous and most frequently collected, while *Typhlodromus caudiglans* Schuster, *Typhlodromus columbiensis* Chant, *A. fallacis*, *Amblyseius floridanus* (Muma), *Amblyseius ovatus* (Garman), and *Amblyseius rosellus* Chant were collected incidentally. A frequency table was developed to indicate overwintering site preferences for the three major species among the four habitats most frequently inhabited (Table 1). *Typhlodromus mcgregori* was present in all twig-spur and bark samples although in much smaller numbers on the bark. On the other hand, *T. occidentalis* was most common in bark samples and *A. cucumeris* most frequently collected from cover samples. All of the incidentally collected species were taken from cover, except that *T. caudiglans* was taken from twig-spurs and *T. columbiensis* from bark. Although *T. mcgregori* was about the only species present in derelict pear, apricot, peach, plum, cherry, and apple orchards, they were present in

Table 1. Frequency of occurrence for the three most common phytoseiids among the habitats they most frequently inhabited.

Species	Frequency[a]			
	Twig-Spur	Bark	Cover	Soil
T. mcgregori	100.0	100.0	66.7	28.6
T. occidentalis	18.2	40.0	22.2	0.0
A. cucumeris	0.0	20.0	88.9	71.4

[a]Frequency was computed as a percentage of all samples taken for each habitat.

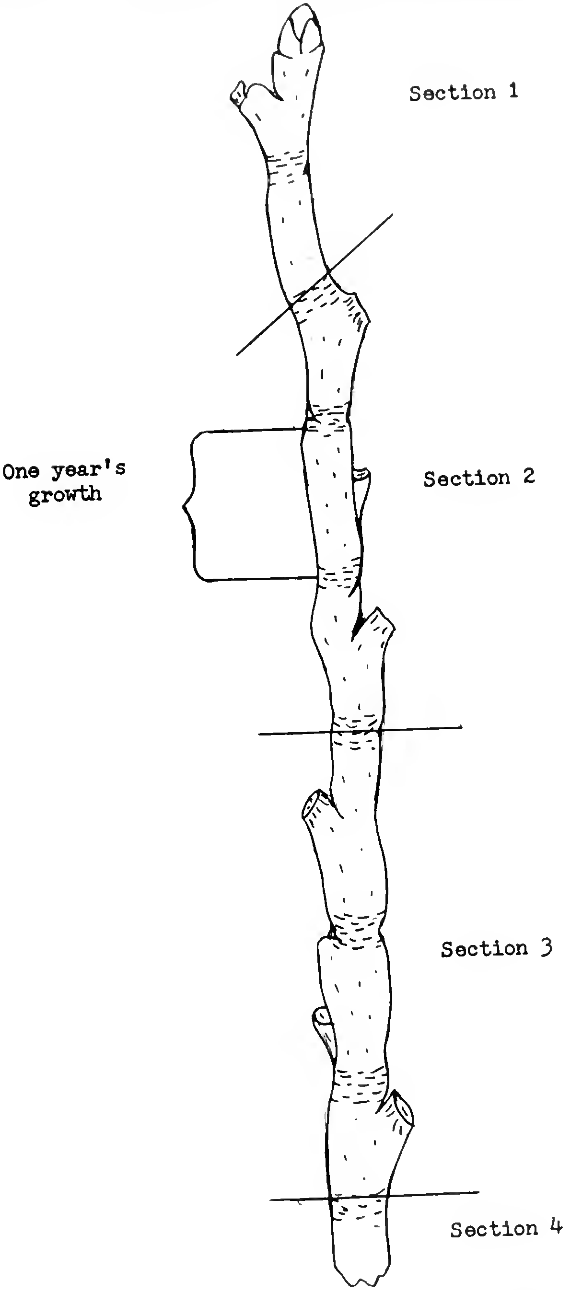

Figure 1. Division of the twig into growth sections: section 1 — terminal two years, section 2 — area 3-5 years old, section 3 — area 6-8 years old, and section 4 — area 9-15 years old.

almost all of them and were much more numerous in apple orchards than any of the other tree fruits.

The numbers of mites collected from green and falling leaves were contrasted in the fall of 1967. *Typhlodromus mcgregori* numbers on the falling leaves were not significantly smaller than those on the green leaves still adhering to the tree ($t = 1.40$. $t(21)(.95) = 2.08$). In this analysis the green leaves for October and November were pooled. A similar analysis for *T. occidentalis* resulted in the same conclusions, the numbers on the falling leaves were not significantly smaller than those on the green leaves still attached to the tree ($t = 1.40$, $t(13)(.95) = 2.16$). *Typhlodromus occidentalis* migrated from the leaves to their overwintering sites at about the same time *Tetranychus urticae* Koch migrated to the trunk and cover in 1968, and since *T. urticae* usually migrates earlier than the data were gathered for *T. occidentalis* in 1967, the few predators remaining on the leaves may have been merely incidental and not indicative of the behavior of most members in the population.

The few *T. mcgregori* observed on the twigs and spurs appeared to prefer sites beneath the corky abscission layers of the fruit stalks. The area of the twig that was 3 to 5 years old maintained the roughest portions of twigs, primarily because of the remaining corky abscision scars of former leaf petioles and fruit stalks. The twigs lost most of their corky material and became smoother after five years, reducing the available overwintering sites. The terminal two years of growth characteristically displayed dense pubescence, but few good hibernating sites. *Typhlodromus mcgregori* moved from the leaves into the abundant overwintering sites on the 3 to 5 year old portions of the twigs in the fall.

Twigs were sampled during the 1967-68 winter to test the hypothesis that *T. mcgregori* preferred the region from 3 to 5 years old for hibernating (Table 2). An analysis of variance was used to determine if there were significant differences among the three sections tabulated in Table 2 (Table 3). Since the variance was significant, the section means were tested (t-test) to find which sections had significantly higher numbers. The only ones which were determined to be significantly different were sections 1 and 3 ($t = 5.04$, $t(8)(.95) = 2.31$). It appears that the collection on February 3 in section 1 had a deciding influence on the significance tests.

Data for winter mortality rates of *T. mcgregori* were pooled each month for all five blocks, since the numbers of mites were too small to analyze the trees separately (Table 4). An analysis of variance suggested that there was no significant winter mortality within the orchard ($\alpha = .05$). If there were significant mortality of the summer populations during the winter, it would have been when they were finding their hibernacula or in the early spring after they had left there sites. When the mortality reported by Anderson and Morgan (1958), Chant (1959) and Putman (1959) occurred is yet to be determined.

Table 2. Number of *Typhlodromus mcgregori* per cm^2 in each twig section from a derelict orchard in Mapleton, Utah.

Section and Date	Mites per Section	Mites per (sq cm) Surface Area	Sample Mites per 1800 sq cm[a]
Section 1			
March 15, 1967	1800.30	1	1.00
February 3, 1968	1493.12	34	40.97
March 2, 1968	1452.84	4	4.94
March 23, 1968	1649.30	11	11.96
March 29, 1968	1776.74	9	9.09
Mean			13.59
Section 2			
March 15, 1967	2689.82	26	17.45
February 3, 1968	2648.72	39	26.53
March 2, 1968	2669.98	24	16.22
March 23, 1968	2287.74	29	22.83
March 29, 1968	2105.94	13	11.11
Mean			18.83
Section 3			
March 15, 1967	2860.44	5	2.34
February 3, 1968	2610.64	9	4.48
March 2, 1968	3754.24	10	4.78
March 23, 1968	3273.26	13	7.14
March 29, 1968	2373.26	7	5.11
Mean			4.77

[a] The number of mites in each sample is determined as the number of mites per 1800 cm^2 of twig surface area.

Table 3. Summary of the analysis of variance of the data from Table 2, based on mites per 1800 cm^2 of twig surface area.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean	Square F-Ratio
Mean	1	173.80	173.80	
Twig sections	2	10.32	5.16	3.68*
Experimental error	12	16.84	1.40	
Total	15	200.96		

*Significant at $\alpha = .05$.

Table 4. Numbers of *Typhlodromus mcgregori* collected from twigs and spurs of a derelict apple orchard near American Fork, Utah.

Month	Mites per 500 Twigs *in* each Block					
	1	2	3	4	5	Total
December	8	11	4	1	12	36
January	7	22	7	2	7	45
February	8	9	5	1	4	27
March	14	5	3	4	1	27
April	13	15	11	0	8	47

Discussion and Conclusions

Mites of the genus *Typhlodromus* have been observed overwintering as adult females in the northern temperate fruit orchards, although there is some question of the location of their overwintering sites. Different species seem to prefer different habitats: *T. mcgregori* on the twigs and bark, *T. occidentalis* on bark, and *A. cucumeris* in the cover (Table 1). These results supported the observations of Anderson and Morgan (1958), Putman (1959), and Burrell and McCormick (1964), who found that *Typhlodromus* species were generally arboreal in winter and summer while *Amblyseius* remained primarily in the ground cover. The only arboreal species found in high numbers in the cover was *T. mcgregori* and it has been found rather commonly in the cover during the summer also (Jorgensen, unpublished data). *Amblyseius cucumeris* was occasionally collected from the bark, but it was only incidental and probably not in its preferred overwintering site.

Chant (1959) found that nearly all *T. finlandicus*, *T. tiliae*, and *T. umbricatus* moved to the twigs and branches before the leaves fell in the autumn months. He reported an increase in the number of mites on green leaves as other leaves began to turn yellow, but mites were not found on yellow falling leaves or on the ground cover. The number of *T. mcgregori* on green leaves in central Utah did not increase as other leaves turned yellow, but there were many collected from falling leaves and in the ground cover. It appears that substantial numbers of *T. mcgregori* fell to the ground cover with dropping leaves, although it is likely that the data from the yellowed falling leaves would have been misrepresentative if the major mite movement to twigs and bark had occured before the sampling began.

Typhlodromus occidentalis moved from the leaves to the bark at about the same time as *T. urticae*. The lack of change in the numbers of predators on the leaves during October and November is likely due to the fact that the major movement had already occurred and only incidental specimens remained — the fate of which is probably not indicative of the population as a whole.

Putman (1959) suggested that arboreal phytoseiids are guided in seeking overwintering sites by two responses — thigmotactic and chemotactic (seeking objects of animal origin). The thigmotactic response was suggested when he found hibernating mites primarily in protected crevices; and the chemotactic when large numbers were found in strips of cardboard containing oriental fruit moth (*Grapholitha molesta* Busck) cocoons placed on the trees, as opposed to few mites in similar strips without the cocoons. The twig dissections in this study confirm Putman's (1959) findings since overwintering *T. mcgregori* were found primarily in protected crevices and spent insect egg cases. The thigmotactic response in locating overwintering sites was supported by the predominance of mites on portions of the twigs from 3 to 5 years old where crevices are more numerous. Thigmotaxis seems to be more influential than chemotaxis in the searching behavior for overwintering sites by *T. mcgregori*.

All preceeding studies on winter mortality of phytoseiids have reported rather high mortality rates. Chant (1959) and Anderson and Morgan (1958) both reported mortality rates over 90%; but since both studies were based on comparisons of fall and spring mite populations on green leaves, an error could have been introduced if a large number of mites fall to the ground with the autumn leaf drop and do not move back onto the tree in the spring. Chant (1959) reported that almost all of the mites left the leaves before they began to fall, so the reported high mortality was likely, but a more precise measurement is possible by periodically sampling the overwintering population. *Typhlodromus mcgregori* did not appear to suffer any winter mortality between December and April, thus whatever mortality occurred must have been before December or after April, and these two periods may result in mortality as severe as those reported by Chant (1959) and Anderson and Morgan (1958).

If predaceous mites are to be considered for use in integrated control of phytophagous mites, their overwintering sites and mortality rates must be known. Their usefulness is determined, in part, if high spring populations can be provided to counteract an early spring build-up of the pest species. By knowing the principal overwintering sites a grower could manage his trees to provide abundant sites for the predators and direct pesticide treatments to avoid them. Gilliatt (1935) and Chant (1959) reported that dormant sprays reduced phytoseiid populations in addtion to the eggs of phytophagous species. Since most of the *T. mcgregori* overwinter on the twigs, they are extremely vulnerable to dormant sprays. On the other hand, *T. occidentalis*, which overwinter primarily in bark of the trunk and scaffold limbs, is less vulnerable since the deeper bark crevices provide better protection from pesticides. This is supported by the fact that *T. mcgregori* is seldom found in commercial orchards of central Utah (Duke, Croft, and Jorgensen; 1968) where *T. occidentalis* is frequently abundant. Based on these observations, it appears that *T. mcgregori* would be difficult to manage in an integrated control program since it is vulnerable to dormant sprays, which are usually an integral part of an integrated control program in tree fruit orchards. The overwintering habits of *T. occidentalis* make it a more promising predator in integrated orchards.

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SPIDERS OF THE NATIONAL REACTOR TESTING STATION[1]

Dorald M. Allred

Ecological investigations conducted by Brigham Young University from June 1966 to September 1967 at the National Reactor Testing Station in southeastern Idaho (Figs. 1, 2) were directed specifically toward the ectoparasites of vertebrates (Allred, 1968). Secondarily, however, some ground-dwelling, free-living arthropods were collected in can pit-traps used for the capture of reptiles and rodents. Considering the relatively little effort expended, an unusual variety of spiders was collected. These were kindly identified by Dr. Willis J. Gertsch, American Museum of Natural History. Their listing here should provide a basis for further studies of these important arthropods in the Great Basin and other desert areas of the western United States.

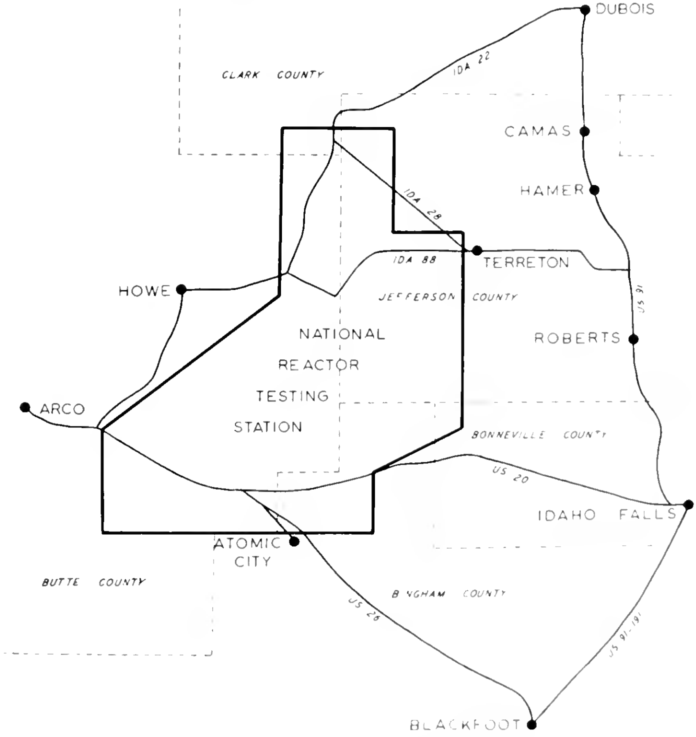

Fig. 1. Location of the National Reactor Testing Station in relationship to some cities in southeastern Idaho.

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[1] BYU - AEC publication no. C00-1559-3 under sponsorship of the Atomic Energy Commission

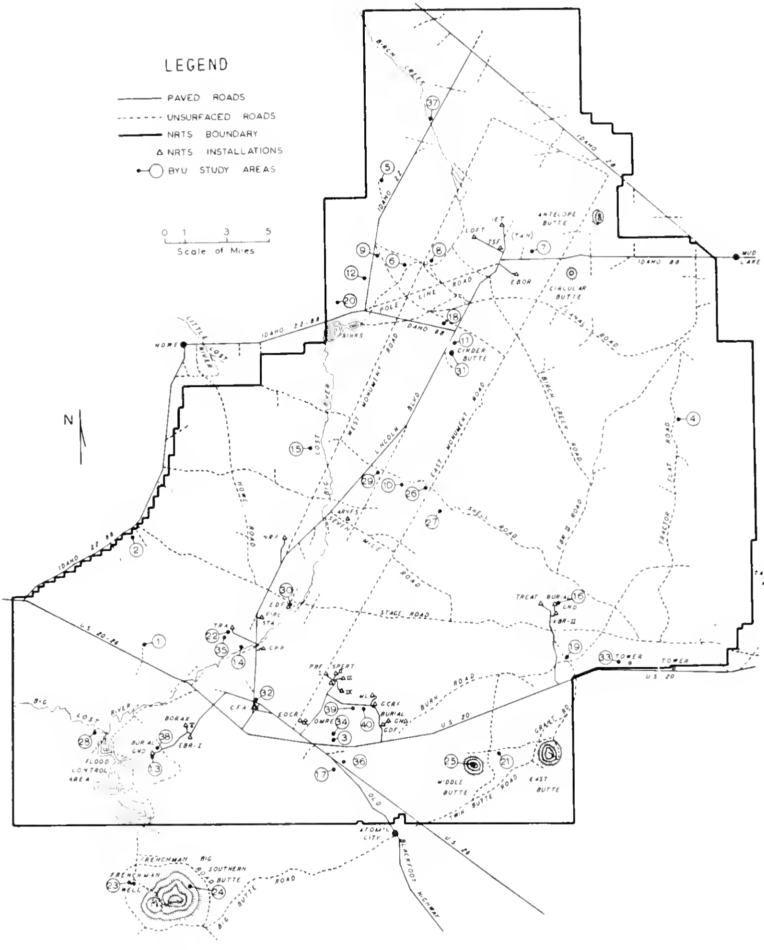

Fig. 2. Principal study areas at the National Reactor Testing Station.

Annotated List of Species

Antrodiaetus montanus: m*; area 6; Oct.

Calilena restricta: 15m 7f 5im; areas 1-12 (except 4, 5, 9), 18; June-Oct. (mostly Aug.).

Callilepis eremellus: m f; area 1, 19; June, July.

Castianeira descripta: f; area 3; Sept.

Ceratinella acerea: f; area 10; May.

Circurina grandis: 1m; area 21.

C. parma: 13m 2f; areas 6, 10, 11, 12, 23; April, Oct. (mostly), Nov.

C. utahana: m; area 11; Nov.

Circurina new species: 6m; areas 6, 10, 21; Oct., Nov.
Dictyna coloradensis: 2m 2f; area 10; July.
Drassodes robinsoni: 4m 2f 8im; areas 1, 2, 6, 7, 10; June, Aug., Oct., Nov.
Drassyllus mannellus: 7m 3f 1im; areas 1, 3, 6, 10, 18; May-July, Sept.
Ebo mexicanus: 5f; areas 1, 6, 7; June, July, Nov.
Enophognatha wyuta: f; area 10; June.
Euryopis scriptipes: m; area 2; July.
Gnaphosa brumalis: 9m 10f 2im; areas 3, 6, 8; June-Aug.
Gnaphosa sp.: 2m 1f 8im; areas 1, 2, 7, 8, 10, 11; April-Aug.
Haplodrassus eunus: 15m 14f 11im; areas 1, 6, 7, 10, 11, 12, 21; April, May, Oct., Nov.
Herpyllus sp.: im; area 8; Aug.
Latrodectus hesperus: 13im; areas 8, 12; July-Sept.
Metaphidippus sp.: im; area 6; July.
Micaria foxi: m f; areas 1, 3; June, Aug.
M. gosuita: f; area 12; Sept.
Micaria new species A: 3m 4f; areas 3, 12; June (mostly), Aug.
Micaria new species B: 2m areas 2, 12; June, Aug.
Misumenops sp.: im; area 10; July.
Pardosa new species: 2f; area 8; July.
Pellenes washonus: m; area 12; July.
Phidippus altanus: m; area 3; Aug.
P. formosus: m; 1im; areas 3, 7; Aug.
Philodromus alascensis: 1im; area 23.
Poecilochroa atomistica: f im; areas 2, 3; July, Aug.
Schizocosa avida: 46m 34f 154 im; areas 1, 2, 3, 6, 7, 8, 10, 11, 12, 18, 19, 21, 23; males were taken from April to July (mostly in July), females from April to Aug., and immatures from April to Nov. (mostly Aug., Oct., Nov.).
Steatoda albomaculata: f; area 3; Sept.
Tarentula kochi: 37m 19f 13im; areas 1, 3, 6, 7, 10, 11, 12, 23; June, Aug.-Nov. (mostly Oct.).
Thanatus altimontis: 9m 1f; areas 1, 2, 3, 7, 12; June-Aug.
Xysticus coloradensis: 10m 1im; areas 2, 5, 6, 7, 11, 12, 18; June, July, Sept.-Nov.
X. knowltoni: 7m 5f 1im; areas 1, 3, 10, 12; May-July, Nov.
X. montanensis: 3m 3f; areas 1, 3, 7, 10; April-June.
X. nigromaculatus: 2m; areas 7, 10; June.
X. gulosus: m; area 6; Oct.
Zelotes pullatus: 11m 8f 2im; areas 1, 2, 3, 7, 10, 11, 12; April-Oct.
Z. puritanus: 4f; areas 2, 3, 19; July, Aug.

*m = adult male, f = adult female, im = immature or juvenile.

SUMMARY

From June 1966 to September 1967 approximately 500 spiders representing 42 species in 31 genera were collected in can pit-traps at the National Reactor Testing Station in Idaho. Four of the species are new to science. The greatest variety of species was found in study area 10 where the vegetation analysis was 68% *Artemisia*, 7% *Opuntia*, 7% mixed grasses, and 5% miscellaneous forbs. The fewest numbers of species were found in study areas 7 and 11, typified predominantly by *Chrysothamnus* plants. Males of all species of spiders combined were collected from April to November. Greatest numbers were found in October. Females of all species were taken from April to November, with slightly more in October than in other months. Immature spiders also were found from April to November, with greatest numbers occurring in August, October, and November. The species that were the most widespread over the station are *Schizocosa avida* and *Calilena restricta*. The most abundant species was *S. avida; Tarentula kochi* was only half as abundant as *S. avida*, but twice as common as any other species.

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INDIVIDUAL RODENT MOVEMENTS IN UPPER SONORAN DESERT OF CENTRAL NEVADA

Most studies of distances traveled by animals suffer from the impossibility of being certain that an animal cannot travel farther than one imagines. Even investigations on islands or in other physically limited sites are apt to be biased by the limits themselves, and thus can be extended to larger areas only at peril of underestimation. For this reason, it seems imprudent—and probably delusive—to calculate "average" distances unless one can be sure that the greatest distances moved by animals will in fact be recorded, or at least recognizes the inadequacies accepted. The maximum distances known to have been moved, however, are useful in judging the adequacy of experimental design in investigating the significance and actual validity of such ideas as home range, and in studies of habitat utilization.

During a study of habitat selection by kangaroo mice (*Microdipodops megacephalus* and *M. pallidus*) conducted in central Nevada in 1960 and 1961, all rodents caught at surveyed points were marked by toe-clipping and released at the traps, in an effort intended to reveal interactions of kangaroo mice with other species.

Trapping was carried on at three places where Hall (Mammals of Nevada, pp. 379-403,. 1946) had found the two species of kangaroo mice to be sympatric. The dominant vegetation at all three may be referred to the Little Greasewood-Shadscale (*Sarcobatus baileyi-Atriplex confertifolia*) association of Billings (Butler Univ. Bot. Stud., 7: 89-123, 1945). At each area, small Sherman traps baited with rolled oats were set within 0.5 yard (0.5 m) of positions 10.00 yards (9.14 m) apart in grid patterns. The grids, their accuracy controlled by stakes at the 20.00-yard (18.28-m) intersects, were extended as accumulating data on kangaroo mice dictated. The areas, and the greatest distances between trap positions on the grids there, were (i) Big Smoky Valley, 5,650 ft, 4.75 miles NE San Antonio, Nye Co., 439 yards (401 m); (ii) Granite Springs Valley, 4,000 ft, 21 miles W and 2 miles N Lovelock, Pershing Co., 241 yards (220 m); and (iii) Penoyer Valley, 4,800 ft, 15 miles N Groom Baldy, Lincoln Co., 632 yards (579 m). For each individual, the points of capture were expressed in rectilinear coordinates (Ghiselin, Amer. Midland Natur., 79: 242-246, 1968). For each, the distances between all sites of capture were calculated, and the greatest distance for each individual was selected by a computer routine utilizing the Pythagorean theorem. The results are set forth in Table 1. To indicate comparative sample sizes, numbers of captures and of individuals involved are included.

The field work was aided by grants from the Wisconsin Alumni Research Foundation and the National Science Foundation (G 14908, administered by W. G. Reeder). I am grateful to Dr. Reeder for his counsel.— Jon Ghiselin, *Dept. of Zoology, University of Wisconsin, Madison 53706. (present address: Biology Dept., Lycoming College, Williamsport, Pa. 17701).*

Table 1.
Greatest known movements of marked mammals.

Species	Captures				Individuals				Max. Dist. (Yards) Between Captures		
	♂	♀	Sex?	Σ	♂	♀	Sex?	Σ	♂	♀	Sex?
Ammospermophilus leucurus	15	9	11	35	10	8	10	28	226	139	89
Perognathus longimembris	251	183	88	522	109	95	79	283	291	202	148
Perognathus parvus	1	12	0	13	1	1	0	2		70	
Microdipodops megacephalus	37	9	0	46	13	5	0	18	459	54	
Microdipodops pallidus	59	71	2	132	18	25	2	45	262	149	
Dipodomys ordii	0	8	0	8	0	1	0	1		67	
Dipodomys microps	205	158	11	374	61	42	11	114	464	316	
Dipodomys merriami	52	10	2	64	19	4	1	24	155	180	14
Onychomys leucogaster	0	4	0	4	0	2	0	2		152	
Onychomys torridus	3	1	0	4	2	1	0	3	180		
Peromyscus maniculatus	30	15	2	47	14	8	2	24	305	202	

SCIENTIFIC NOTES

AN ALBINO PACIFIC TREE FROG, HYLA REGILLA, FROM DEATH VALLEY, CALIFORNIA

On 25 March, 1967, a partially albino ♀ *H. regilla* (snout-vent, 35.0 mm) was collected at Saratoga Springs, Death Valley National Monument, San Bernardino Co., California. Except for color, the frog appeared normal. Her behavior at capture was normal and her ovaries contained well developed, pigmented eggs. Four lung-worms (*Rhabdias ranae* Walton) were found, but there was no evidence of pathological damage. No other abnormally colored frogs have been found in over a year of collecting from this population. The specimen (A-540) is on deposit in the Biology Museum, University of Nevada, Las Vegas.

The frog's dorsal coloration is broken by extensive non-pigmented areas, but her eyes appear to be of normal color. The pigmented skin appears to be lighter than normal for the population. Four melanophore counts taken on a 5 x 3 mm section of pigmented skin from near the front leg of the albino and a normal ♀ *H. regilla* bear this out X normal $= 4375/\text{mm}^2$, X albino $= 3525/\text{mm}^2$, $P<.001$). The normal pattern, although interrupted, is evident on the pigmented areas of the albino.

To my knowledge, only one other case of albinism has been reported for *Hyla regilla*. Jameson and Myers (Herpetologica, 13:74, 1949) reported an albino *H. regilla* from Oregon that developed from non-pigmented eggs. Hensley (Publ. Mus. Michigan State Univ. Biol. Ser., 1: 135-59, 1959) reiterated the Oregon record, but did not report any other instances. I have found no other reports of albinism in *H. regilla* since 1959. However, Wright and Wright (Handbook of frogs and toads of the U.S. and Canada, Comstock Publ .Co., New York. 1949) reported collecting a *Hyla regilla* in Las Vegas, Nevada, in 1925, that was ". . . very yellow with very indistinct pattern."[sic]. Although the authors made no comment, the frog may have been an albino. In several hundred tree frogs from the Las Vegas area, I have not seen a yellow one. Greenish-gray is a common color, but the pattern is always distinct.

I wish to thank Dr. James E. Deacon for reviewing the manuscript and Dr. Bert B. Babero for identification of the parasites. This study has been supported in part by U. S. National Park Service contract no. 14-10-0434-0989 to Dr. James E. Deacon. Fenton R. Kay, Department of Biological Sciences, University of Nevada, Las Vegas, 89109.

Volume XXIX, No. 3
September 30, 1969

The Great Basin NATURALIST

Published by
Brigham Young University

GREAT BASIN NATURALIST

The Great Basin Naturalist
PUBLISHED AT PROVO, UTAH BY
BRIGHAM YOUNG UNIVERSITY

VOLUME XXIX September 30, 1969 No. 3

NEW SYNONYMY AND RECORDS OF PLATYPODIDAE AND SCOLYTIDAE (COLEOPTERA)[1]

Stephen L. Wood[2]

During the past year the opportunity came for me to study the types of bark and ambrosia beetles (Platypodidae and Scolytidae) in three old, significant collections. The oldest of these is the collection of Count C. G. Mannerheim, presently housed in the Universitetets Zoologiska Museum, Helsinki, Finland. It is noteworthy because it contains the types of species taken in Russian America (mostly Alaska) at an early date when few American species were known. Most of the 17 species of concern here were previously correctly known to specialists; noteable exceptions involve *Bostrichus* (now *Ips*) *tridens*, *Hulurgus* (now *Pseudohylesinus*) *sericeus*, and a new status for *H.* (now *Dendroctonus*) *obesus*.

The second collection considered here, in terms of age priority, is that of Victor von Motschulsky presently housed at the Zoological Institute of the USSR, Moscow. The 26 species of concern here were described largely from Ceylon and, for the most part, have been known to specialists only from the original descriptions and a very few duplicate specimens evidently distributed by Motschulsky. Previous workers were not successful in locating the types and have either ignored the names or have considered the types lost or destroyed. The policy adopted here in this article apparently is consistent with the action of previous workers; that is, specific names of these species were given their normal place in priority, but three generic names, *Anodius* (1860) and *Phloeotrogus* (1863) (=*Xyleborus* Eichhoff, 1864), and *Olonthogaster* (1886) (=*Phloeosinus* Chapuis, 1869) clearly predate the priority of names now used for the genera to which they apply. These names, *Xyleborus* and *Phloeosinus*, have been applied consistently for a century to large genera of almost world-wide distribution and it is not in the interest of nomenclatorical stability that they be changed. Although *Anodius*, *Phloeotrogus*, and *Olonthogaster* have been listed in catalogs in an

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[1] The travel grant that made this report possible was provided by the National Science Foundation through the Entomological Society of America.

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incerta sedis category. I feel they qualify as *nomena oblita*. The case with the monobasic *Genyocerus* (1858) is different. Strohmeyer evidently deliberately named a homonym in the genus *Diapus* to replace *G. albipennis*, the type-species of *Genyocerus*. It apparently has been clearly recognized that *albipennis* belongs to the species group currently assigned to *Diacavus* Schedl, 1939. Contrary to Schedl's (1959:515) statement, the type of *albipennis* is available and the characters of *Genyocerus* are clearly definable as his placement of *albipennis* in *Diacavus* indicates. *Diacavus* was established recently and it involves a limited number of species (about 15) from a restricted region (oriental). For these reasons I place *Diacavus* Schedl in synonymy under the much older name *Genyocerus* Motschulsky (*New synonymy*).

The third collection treated here is part of the Felicien Chapuis material on which his 1869 (and 1873) Synopsis des Scolytides was based. This part of his material is currently housed in the Institut Royal des Sciences Naturelles de Belgique, Brussells. Because a more extensive treatment of the American material contained in this collection is in preparation, only four items of immediate concern are treated here.

My sincere appreciation is extended to the above named institutions for their kindness in permitting me to examine their material; and to Dr. Walter Hackman and Mr. Hans Silfverberg, at Helsinki, Dr. A. N. Zhelochovtsev, at Moscow, and Dr. Roger Damoiseau, at Brussells, for their kindness and cooperation.

In order to resolve some of the problems presented here and to facilitate other work, six American species are described below as new to science. These species are in the genera *Pseudohylesinus* (1), *Phloeotribus* (3), and *Chramesus* (2).

Mannerheim Collection

Of the 17 species of Scolytidae named from Alaska by Mannerheim, subsequent workers have correctly placed most of them. A few have been misidentified. My comments on the collection follow.

Bostrichus affaber Mannerheim (1852)

This species has correctly been referred to *Dryocoetes*. The type is a female.

Bostrichus cavifrons Mannerheim (1843)

Three specimens taken at Sitka by Holmberg are in the Mannerheim drawer with the types, but none has been designated as the type. In another drawer containing general Mannerheim Scolytidae there are eight specimens designated "Spec. typ.," collected by D. Eschscholtz or Blaschke. Evidently the type, collected by Eschscholtz, is among the latter eight specimens. All are of *Trupodendron lineatum* (Olivier) with which this species has correctly been placed in synonymy.

Bostrichus concinnus Mannerheim (1852)

This species has correctly been referred to the genus *Ips*. The type is a female.

Bostrichus interruptus Mannerheim (1852)

This species has correctly been referred to the genus *Ips*. The type is a female.

Bostrichus nitidulus Mannerheim (1843)

This species has correctly been referred to the genus *Pityophthorus*. The type is a female.

Bostrichus semicastaneus Mannerheim (1852)

This species has correctly been made a junior synonym of *Dryocoetes autographus* (Ratzeburg). The sex of the type was not determined.

Bostrichus septentrionis Mannerheim (1843)

This species has been made a junior synonym of *Dryocoetes autographus* (Ratzeburg). A specimen bearing this name was not found in the Mannerheim collection.

Bostrichus terminalis Mannerheim (1843)

This species belongs in the family Cisidae.

Bostrichus tridens Mannerheim (1852)

This species has correctly been referred to the genus *Ips*. The type is a female exactly identical to the female type of *Ips interruptus* (Mannerheim) (*new synonymy*). The name *interruptus* appears first on the page, but I exercise the right as first revisor in this instance and select the name *tridens* for this species. The morphological form having a greatly enlarged female frons, generally known as *Ips tridens*, does not require a new name; it will be treated in the near future in a detailed study by Dr. Gerald Lanier.

Cryphalus striatulus Mannerheim (1853)

A specimen bearing this name could not be found in the Mannerheim collection. It evidently is the species currently known as *Trypophloeus nitidus* Swaine.

Hylastes cristatus Mannerheim (1853)

A specimen bearing this name could not be found in the Mannerheim collection. It has been treated as a junior synonym of *Hylurgops subcostulatus* (Mannerheim).

Hylastes subcostulatus Mannerheim (1853)

This species has correctly been transferred to the genus *Hylurgops*. There were no specimens under this name in the Mannerheim material; however, it is easily recognized from the original description.

Hylurgus nigrinus Mannerheim (1852)

This species has correctly been referred to the genus *Hylastes*. The type is a female.

Hylurgus obesus Mannerheim (1843)

This species has correctly been referred to *Dendroctonus*. While my (Wood, 1963) revision of *Dendroctonus* was in press a delayed comparative note on the type of *D. rufipennis* (Kirby) was received indicating that *obesus* is a junior synonym. In my absence the correction was properly placed in the synonomy but the senior name was not substituted elsewhere in the manuscript. Since then I have re-examined the types of both *obesus* and *rufipennis*. There are obvious synonyms, with the name *rufipennis* having priority (*new status*).

Hylurgus pumilus Mannerheim (1843)

This species has correctly been referred to the genus *Dolurgus*. The sex of the type was not determined.

Hylurgus rugipennis Mannerheim (1843)

This species has correctly been referred to the genus *Hylurgops*. The specimen labeled "Type" in the Mannerheim type collection was not collected by Eschscholtz and, therefore, probably is not actually the type. Seven other specimens of this species in the Mannerheim material are from Sitka, but were also taken by other collectors.

Hylurgus sericeus Mannerheim (1843)

Under this name in the Mannerheim collection are two specimens. The second specimen belongs to the genus *Leperisinus* and is from Louisiana. The first is from Sitka, collected by Blaschke, and is considered to be the type. This specimen is a female of the species generally known as *Pseudohylesinus grandis* Swaine (*new synonymy*); Swaine's name, therefore, must be placed in synonomy. *Pseudohylesinus sericeus* of Swaine and Blackman is an unnamed species (see below).

Polygraphus saginatus Mannerheim (1853)

This species has correctly been placed as a junior synonym of *P. rufipennis* (Kirby). The only specimen of this species in the Mannerheim material is a female without locality data, bearing the generic and specific names, but no author or other identifying information. It could be the type, but it is not so designated.

Motschulsky Collection

The types of 26 species of Scolytidae and Platypodidae are in the Motschulsky collection. Synonymy for nine of the species has been suggested by previous workers, based on an examination of the original descriptions or of a very few duplicate specimens presumably distributed by their author. The taxonomic placement of the 17 remaining species has not been clear. It was noted that labels were mostly written in German and did not always correspond with the published type locality designated by Motschulsky. However, after examining the entire Motschulsky collection presently available, I see no reason whatever to question the types as they are presently designated. Five of them have been carefully remounted on the same pin above the original microcard, and all bear a red type label in addition to the original designation. My comments on the alphabetically arranged Motschulsky species follow.

Anodius denticulatus Motschulsky (1860)

Six female specimens are mounted individually on six microcards on one pin. The upper five are *Xyleborus perforans* Wollaston; the sixth specimen, placed in the lowest position on the pin, is *Xyleborus similis* Ferrari. I here designate the uppermost specimen as the lectotype of *denticulatus* Motsch. (*new synonymy*).

Anodius distinctus Motschulsky (1866)

One female specimen. Comparative material was not at hand for varification, but this species is *Coccotrypes floridensis* Schedl which is the species I have recognized as *C. carpophagus* Hornung. Schedl refers Hornung's name to a different species, *C. pygmaeus* Eichhoff; I have not yet verified his synonymy. Regardless of how the later problem is resolved *Coccotrypes distinctus* (Motsch.) is a senior synonym of *C. floridensis* Schedl (*new synonymy*).

Anodius piceus Motschulsky (1863)

One female specimen. This species is *Xyleborus indicus* Eichhoff. The apices of the elytra are immersed in glue. The pronotum is subquadrate, the color is dark, the basal half of the elytral declivity may be very slightly more convex than in many *indicus*, but it is within the range of variation for this species. *Xyleborus piceus* (Motsch.) has priority and must replace *X. indicus* Eichhoff (*new synonymy*).

Anodius tuberculatus Motschulsky (1863)

Two female specimens. They were compared directly to authentic specimens of *Xyleborus perforans* Wollaston; there is no question as to the synonymy. Wollaston's name has priority (*new synonymy*).

Eccoptopterus sexspinosus Motschulsky (1863)

Three females labeled "India occidental, Birma." The length of these speciments is about 2.3 mm., and the second and third pairs of teeth on the elytral declivity are smaller, with the second pair closer together than in my specimens of *E. spinosus* (*Olivier*). In spite of these differences, I feel the previously suggested snyonymy is correct.

Genyocerus adustipennis Motschulsky (1859)

One female specimen, from Japan. An examination of the literature treating the Platypodidae of Japan strongly suggests that this is *Crossotarsus niponicus* Blandford. Synonymy should await varification of this observation.

Genyocerus albipennis Motschulsky (1858)

One female speciman labeled "Aus Indien or (word illegible)." It is about 2.5 mm. in length; the frons is elaborately ornamented by slight impressions on lateral areas that extend dorsad to the upper level of the eye, with tufts of coarse, long hair occupying the lateral thirds from the upper level of the eye to two-thirds of the distance toward the mandibles and projecting forward a distance equal to the length of the head then curling back toward the mouth and touching the mandibles; additional tufts arise on the mouthparts and curl upward to the middle of the frons; median one-third to one-half of frons glabrous; base of pronotum with about a dozen coarse pores. This is a *Diacavus* species reminiscent of *quadriporus* Schedl, but distinct. However, as indicated above *Diacavus* must be placed in synonymy under the much older *Genyocerus*.

Hylesinus granulifer Motschulsky (1863)

Two male specimens mounted on one pin. These specimens agree in all details with my male of *H. despectus* Walker, from Tonkin.

Hylesinus sericeus Motschulsky (1866)

One female specimen. It belongs to the genus *Cryphalus*, and probably is *C. indicus* Eichhoff. The size, sculpture and setae fit *indicus*, but specimens were not at hand for comparison.

Hypoborus cinerotestaceus Motschulsky (1866)

One female specimen in very poor condition. It is about 1.3 mm. in length, with erect, interstrial rows of stout setae, the length of each less than half as great as distance between rows. It is similar to *paganus* Eichhoff or *pallidus* Eichhoff, but specimens were not available for comparison.

Hypoborus dorsalis Motschulsky (1866)

Two females and one male mounted on one card on one pin. They are of *Cryphalus indicus* Eichhoff, or very near. The size, sculpture and setae are as in *indicus*, however, specimens were not available for direct comparison.

Hypoborus nebulosus Motschulsky (1866)

Two specimens, probably males, with the frons hidden. Also of *Cryphalus*, probably *indicus*. The size, sculpture and setae are as in *indicus*, however, specimens were not available for direct comparison.

Olonthogaster nitidicollis Motschulsky (1866)

One female specimen. This is a large *Phloeosinus* similar to *asper* (Sampson). Specimens were not available for comparison.

Olonthogaster nitidifrons Motschulsky (1866)

One male specimen. This is a *Phloeosinus* species presently unknown to me. It is about 2.5 to 2.7 mm. in length; declivital interstriae 1 and 3 each bear three or four widely separated, sharply pointed teeth.

Phloeotrogus attenuatus Motschulsky (1863)

One female specimen. This specimen is *Xyleborus sordicauda* (Motsch.) (*new synonymy*) and is known to specialists by that name. It agrees completely with my homotype.

Phloeotrogus bidentatus Motschulsky (1863)

One female specimen labeled "India occidental." This specimen agrees with the species generally known to specialists as *Xyleborus bidentatus* (Motsch.) My specimen was compared directly to the type.

Phloeotrogus crassiusculus Motschulsky (1866)

Three females labeled "India occidental," mounted on individual microcards on one pin. The specimens are somewhat greasy, making the transition from shiny to apaque areas on the elytra difficult to see. My homotype (2.8 mm.) is very slightly larger than the types, but it is clearly *Xyleborus semiopacus* Eichhoff (*new synonymy*). Motschulsky's name has priority.

Phloeotrogus obliquecauda Motschulsky (1863)

Four females labeled "India occidental." This species is allied to *Xyleborus minor* (Stebbing) and is of the same size and proportion; however, the declivital sculpture and armature are much more nearly like *X. tachyderus* (Zimmermann). It is a species presently unknown to me.

Phloeotrogus sordicauda Motschulsky (1863)

Two female specimens. These specimens were compared to my specimen and the characters agree completely. It is the species known generally among specialists as *Xyleborus sordicauda* (Motsch.).

Phloiotribus subquadratus Motschulsky (1866)

One specimen. This specimen superficially resembles the genus *Phloeotribus*, but it belongs to the family Anobiidae.

Platypus caudatus Motschulsky (1863)

Six male specimens labeled "India oriental." all badly covered by fungal growth, unquestionably are *Platypus solidus* Walker as was previously suggested.

Platypus cordatus Motschulsky (1863)

Four female specimens labeled "India oriental." These specimens agree with my female homotype except that the major pronotal pores are very slightly smaller. It is a junior synonym of *Platypus solidus* Walker (*new synonymy*).

Platypus luniger Motschulsky (1863)

Three males and three females labeled "India oriental." Notes and diagrams indicates this species is *Platypus caliculus* Chapuis (*new synonymy*).

Platypus rotundicauda Motschulsky (1863)

Two female specimens labeled "India oriental." At the present time I am not familiar with the *Platypus* species to which this name should be associated.

Tomicus adusticollis Motschulsky (1863)

One female labeled "Ceylon." This specimen is about 2.2 mm. in length; my notes and diagram indicate it is *Xyleborus pumilus* Eggers. A specimen was not available for direct comparison (*new synonymy*).

Tomicus quadrispinus Motschulsky (1863)

One female labeled "India or Birma." This specimen is about 2.5 mm. in length; it is either *Xyleborus amphicranulus* Eggers, a small specimens of *X. emarginatus* Eichhoff or very closely related. More specimens of these species are required to more fully understand their ranges of variation.

CHAPUIS COLLECTION

Only a few items relating to the Chapuis (1869) types are mentioned here, the remainder will be treated in a later publication.

Hylastes vastans Chapuis

The female holotype is labeled "Mexico, Dy." It was compared directly to my homotype of *Hylastes gracilis* LeConte and is of the same species. LeConte's name has priority (*new synonymy*).

Dendroctonus parallelocollis Chapuis

The type evidently is a female; it is labeled "Mexico. Dy." My concept of this species (1963) was based on specimens supposedly compared to this type by Hopkins, Eggers, and Schedl. All clearly were in error. The type is identical to *D. aztecus* Wood (*new synonymy*). The species for which the name *parallelocollis* has been used in all references except Chapuis (1869) must now take the name of the only available junior synonym, *D. approximatus* Hopkins.

Phloeotribus obliquus Chapuis

The Chapuis series consists of four specimens, two labeled as types, and two as "ex-typus" identified by Chapuis. The first syntype is a female of *P. transversus* Chapuis (types compared directly); the second syntype and both of the other specimens (ex-typus) are of the one species. I here designate the second syntype to be the lectotype of *P. obliquus* Chapuis. There is no indication on either specimen or in subsequently studied material to suggest a Mexican (or even a Central American) origin for specimens of this species.

Phloeotribus sulcifrons Chapuis

This species has been widely reported from Central America. The female type, however, from Colombia, is quite different. The female frons is narrowly, rather strongly sulcate from the vertex to the position normally occupied by a frontal fovea in this genus. Pronotal and elytral characters also indicate that *P. sulcifrons* of Blandford and other authors, from Central America, requires a new name (see below).

SUPPLEMENTAL NOTES

Liparthrum Wollaston (1854)

The original spelling of this generic name was *Leiparthrum;* in 1864, Wollaston changed it to *Liparthrum* which was used consistently from then until Bright (1968) declared Wollaston's (1864) action an unjustified emendation, evidently without seriously studying the matter, and reverted to the 1854 spelling. Article 33a of the International Code says a justifiable emendation "is the correction of an incorrect original spelling and the name thus emended takes the date and authorship of the original spelling." This generic name was based on the Greek root *leipo* which transliterates into the Latin *lipo*. Wollaston, in 1864, clearly indicated by a footnote that his emendation was intentional; he evidently assumed his reason for the change was obvious. The spelling *Liparthrum*, therefore, is correct and should be continued in the interest of nomenclaturial stability.

Phloeotribus Latreille (1802/3)

This generic name was originally presented as *Phloiotribus* (Latreille, 1796), a nomen nudum; it was validated in 1802/3 by the same author. Later, Erichson (1836), recognizing the same type of problem in transliterating the Greek root word *phloios* into the Latin *phloeos* as treated above, emended the name to *Phloeotribus*. With one or two minor exceptions (including that of Motschulsky, used above) the spelling *Phloeotribus* has been used consistently from 1836 until an apparent attempt to revive the original spelling by Barr (1969), presumably influenced by Bright. Erichson's emendation was justifiable under article 33a of the International Code and should be preserved.

Chaetophloeus phoradendri Wood, emendation

In the recent validation of this name (Wood, 1969:8), the specific designation inadvertently was spelled *phorodendri*. It should be corrected to *phoradendri* to correspond with the generic name of its host.

Pseudohylesinus pini, n. sp.

This is the species previously known as *Pseudohylesinus sericeus* of Swaine, Blackman, etc., not Mannerheim. As indicated above, the type of Mannerheim's species is of a different species than was treated by Swaine and Blackman.

This species is distinguished from *sitchensis* Swaine by the smaller average size, by the more strongly arcuate sides of the pronotum, by the stouter scales on the female pronotum, and by the host.

Female.—Length 2.6 mm. (paratype 2.3-2.8 mm.) 2.2 times as long as wide; color very dark brown with a mottled pattern of dark and light scales.

A complete description of this species is given by Blackman (1942:24) under the name *P. sericeus*.

Male.—Similar to female except slightly smaller, stouter; frons broadly, more strongly impressed; pronotal scales somewhat stouter.

Type Locality.—Pacific Grove, California.

Type Material.—The female holotype, male allotype and three paratype were collected at the type locality on December 12, 1923, from Monterrey pine; one male paratype is labeled "Carmel Cal., 5-IV-25, F. O. Ballon, *Pinus radiata*."

The holotype, allotype, and paratypes are in my collection.

Phloeotribus quercinus, n. sp.

This species is closely allied to *pruni* Wood, but it may be distinguished by the less strongly attenuate lateral extension of segments of the antennal club, by the absence of submarginal crenulations near the elytral bases, by the coarser pronotal punctures, and by the host.

FEMALE.—Length 2.0 mm. (paratypes 1.8-2.1 mm.), 1.9 times as long as wide; color black.

Frons evenly convex above level of antennal insertion, transversely impressed below, smooth epistomal margin slightly elevated; premandibular lobe small, distinct; surface strongly reticulate, punctures small, obscure, rather close; vestiture fine, hairlike, rather sparse. Antennal club with segments 1 and 2 each very slightly less than twice as wide as long.

Pronotum 0.82 times as long as wide; widest at base, sides arcuate, converging to a slight constriction just before broadly rounded anterior margin; surface reticulate, devoid of all indications of asperities, punctures coarse, moderately deep, separated by distances up to diameter of a puncture; part of median line impunctate in front of middle; vestiture very fine, long.

Elytra 1.35 times as long as wide, 2.0 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; scutellum small, rounded, scutellar notch rather deep; basal margins each armed by 14 rather narrow, high crenulations, devoid of submarginal crenulations; striae weakly impressed toward declivity, punctures moderately coarse, deep; interstriae slightly wider than striae, devoid of punctures, moderately large, rounded granules moderately confused. Declivity convex, steep; striae moderately impressed; interstriae feebly convex, not elevated, granules almost uniseriate. Vestiture consisting of fine, semirecumbent strial hair, and erect, confused interstrial bristles of uniform length, fine at base, becoming stout and shorter toward declivity, each almost equal in length to width of an interspace.

MALE.—Unknown.

TYPE LOCALITY.—Sixteen km. (10 mi.) east of Pachuca, Hidalgo, Mexico.

TYPE MATERIAL.—The female holotype and 22 female paratypes were collected at the type locality on June 10, 1967, 2,600 m., No. 5, by S. L. Wood, in broken *Quercus* branches less than 2 cm. in diameter.

The holotype and paratypes are in my collection.

Phloeotribus destructor, n. sp.

This species is closely related to *frontalis* (Olivier), but it may be distinguished by the absence of the tubercles on declivital interstriae 1 to 4, by the much coarser pronotal punctures, with the interspaces between them devoid of impressed points, and by the different host and distribution.

Male.—Length 2.2 mm. (paratypes 1.8-2.5 mm.) 2.1 times as long as wide; color dark brown.

Frons shallowly, broadly concave from epistomal margin almost to level of upper margin of eyes; lateral margins armed by a pair of moderately large, pointed tubercles at level of antennal insertion; surface shining, subreticulate below, almost rugulose above, marginal areas above tubercles with rather abundant, small, rounded granules; vestiture of rather abundant, coarse, short hair. Segment 1 of antennal club 2.6 times as wide as long.

Pronotum 0.81 times as long as wide; widest at base, sides rather weakly, arcuately converging to a feeble constriction just behind anterior margin, rather narrowly rounded in front; surface coarsely, very closely, rather shallowly punctured, a few granules and fine asperities in anterolateral areas, interspaces between punctures less than half as wide as diameter of a puncture, devoid of impressed points; vestiture of rather fine, moderately abundant, short hair.

Elytra 1.4 times as long as wide, 1.9 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; scutellar notch rather shallow, obtuse; basal margins each armed by 12-14 coarse, overlapping crenulations; striae moderately impressed, punctures deep, rather fine on basal fourth, becoming coarser toward declivity; interstriae as wide as striae, closely crenulate, crenulations confused, each about half as wide as an interstriae, low except at base and much larger at base of declivity. Declivity convex, moderately steep; striae narrowly impressed, punctures rather small; interstriae 1 to 8 equally convex, armed at base by crenulations that increase in size laterally, interstriae on declivital face not at all granulate, uniseriately, finely punctured, except 9 joining costal margin, its elevation and course tubercles continuing to apex. Vestiture of slender, interstrial bristles of uniform length, slightly confused on most of disc, becoming uniseriate toward and on declivity, on declivity each equal in length to distance between rows.

Female.—Similar to male except frons convex, a narrow, transverse impression immediately above epistoma, lateral tubercles absent.

Type Locality.—Morelia, Mochoacan, Mexico.

Type Material.—The male holotype, female allotype, and 5 paratypes were taken in the gardens behind No. 25 Avenida Acueducto at the type locality on June 14, 1965, in a peach tree, No. 57, by S. L. Wood; 12 paratypes were collected 19 km. (12 mi.) east of Carapan, Michoacan, on June 18, 1965, in wild cherry, No. 76, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Phloeotribus furvus, n. sp.

As indicated above, this is the Central American species previously reported as *Phloeotribus sulcifrons* by Blandford (1897) and others. From the type of *sulcifrons* it differs by the convex female frons, by the more closely punctured pronotum, and by the more finely, more closely placed interstrial crenulations (obscurely three to four ranked on each interstriae; only two to three ranked in *sulcifrons*).

MALE.—Length 3.0 mm. (paratype 2.8-3.3 mm.), 1.6 times as long as wide; mature color black.

Frons broadly, shallowly, subconcavely impressed from epistoma to upper level of eyes, lateral margins weakly elevated, except more strongly raised at level of antennal insertions, unarmed, a low, transverse callus at level of antennal insertions; surface strongly reticulate, with rather close, shallow punctures of moderately small size. Antennal scape with a small tuft of rather short hair, segment 1 of club more than eight times as wide as long.

Pronotum 0.80 times as long as wide; basal margin obtusely extended posteriorly, with median fourth more acutely extended; widest just in front of posterolateral angles, rather strongly, arcuately convergent, weakly constricted just before rather narrowly rounded anterior margin; surface very densely, rather coarsely punctured, becoming somewhat granulate on anterior third; anterolateral angles with two or three coarse asperities, a row of small asperities extending along anterior margin to opposite sides; vestiture of minute, dark setae at least in lateral areas.

Elytra 1.03 times as long as wide, 1.4 times as long as pronotum; sides weakly arcuate to base of declivity, rather broadly rounded behind; scutellar notch abrupt, deep, broad; basal margins each armed by 19 low, overlapping crenulations, striae abruptly, narrowly, deeply impressed, punctures small, deep; interstriae twice as wide as striae, dense crenulations narrow, rather high, often obscurely three-ranked, general surface evidently minutely punctured. Declivity convex, steep; interstriae as on disc but slightly narrower, median tubercles larger, others largely absent, 9 moderately elevated from middle of declivity anteriorly. Vestiture of minute, abundant, confused, hairlike bristles, each about equal in length to one-third width of an interstriae.

FEMALE.—Similar to male except frons convex, with an indistinct central fovea, punctures larger, very shallow, antennal scape not ornamented by hair; interstriae 9 less strongly elevated.

TYPE LOCALITY.—Turrialba, Cartago Province, Costa Rica.

TYPE MATERIAL.—The male holotype, female allotype and 29 paratypes were collected at the type locality on March 9, 1964, 2,000 ft. elevation, No. 459, from a broken limb of an unidentified tree, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus vitiosus, n. sp.

This species was confused with *crenatus* Wood until an attempt was made to construct a key to include it. From *crenatus* it is distinguished by the shorter, erect interstrial bristles, by the absence of male strial punctures, and by the greater distribution of pronotal punctures.

Male.—Length 1.3 mm. (paratypes 1.2-1.5 mm.), 1.4 times as long as wide; color very dark brown, vestiture pale.

Frons broadly, deeply concave from epistoma to well above eyes, lateral margins acutely, strongly elevated, attaining a subserrate summit at level of antennal insertion, lower tubercle predominating; surface shining, finely reticulate, punctures not clearly evident; vestiture fine, inconspicuous. Antennal club moderately large, 2.3 times as long as wide.

Pronotum 0.72 times as long as wide; widest on basal fourth, sides arcuately converging to slight constriction just before rather broadly rounded anterior margin; surface subreticulate, rather closely asperate, asperities largely replaced by fine punctures in postermedian area, a few punctures occur almost to anterior margin in median area; vestiture of moderately abundant, short, stout, pale bristles over entire surface.

Elytra 0.91 times as long as wide, 1.4 times as long as pronotum; basal margins each armed by about 12 partly contigious, low crenulations; sides straight and parallel on less than basal half, broadly rounded behind; striae distinctly impressed, glabrous, punctures obsolete; interstriae as wide as striae, almost smooth, small punctures close, confused. Declivity convex, rather steep; a few strial punctures obscurely present. Vestiture consisting of a ground cover of closely set short scales, each scale about twice as long as wide; and interstrial rows of erect, scalelike bristles, each bristle not more than twice as long as ground scales, about half as long as distance between rows or between bristles in a row.

Female.—Similar to male except frons weakly convex, foveate at center, a weak, transverse impression just above epistoma; punctures on pronotum slightly coarser and more widely distributed; strial punctures small, distinctly impressed; occasional very small interstrial granules evident; scales in interstrial ground cover only slightly longer than wide.

Type Locality.—Eight km. (5 mi.) south of Rosamorada, Nayarit, Mexico.

Type Material.—The male holotype, female allotype, and 48 paratypes were collected at the type locality on July 14, 1965, 100 m. elevation, from *Inga paterno*, by S. L. Wood. Additional paratypes were taken in Nayarit as follows: 14 from 48 km. (30 mi.) north of Rosamorada, July 15, 1965, 100 m.; 1 from Los Corchos, July 10, 1965, 10 m.; all from the same host and collector.

Chramesus minulus, n. sp.

This species is closely allied to *acacicolens* Wood, but it is distinguished by the smaller size, by the more slender form, by the much shorter, erect, interstrial scales, and by the much stouter pronotal scales.

FEMALE.—Length 1.25 mm. (paratype 1.3 mm.), 1.8 times as long as wide; color yellowish brown.

Frons weakly convex, somewhat flattened on upper half, a slight, transverse impression just above epistoma; surface minutely rugulose-reticulate, fine punctures indistinct; vestiture short, rather sparse, stout. Antennal club rather small for this genus, 2.0 times as long as wide.

Pronotum 0.80 times as long as wide; widest at base, sides rather weakly arcuate and converging slightly on basal two-thirds, broadly rounded in front; surface rather finely, closely granulate-punctate (largely obscured by scales), becoming finely asperate toward anterolateral anglts; vestiture of short, oval, almost white scales.

Elytra 1.2 times as long as wide, 1.7 times as long as pronotum; basal margins each armed by 13 crenulations; sides almost straight and parallel on slightly more than basal half, rather broadly rounded behind; striae weakly impressed, punctures coarse, sharply impressed, rather shallow; interstriae about one and one-half times as wide as striae, moderately convex, smooth, with minute, confused punctures, each interstriae with a median row of very fine granules. Declivity convex, moderately steep; essentially as on disc. Vestiture consisting of a ground cover of short scales, each scale as long as wide, slightly more than a third as wide as an interstriae; and median interstrial rows of erect scales, each only slightly longer than ground scales and mostly less than twice as long as wide.

TYPE LOCALITY.—Le Ceiba, Honduras.

TYPE MATERIAL.—The female holotype and one female paratype were collected at the type locality, at light, in 1949, by E. C. Becker, the holotype on June 10, the paratype on May 29.

The holotype and paratype are in my collection.

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ZOOGEOGRAPHIC AND SYSTEMATIC NOTES ON THE LACE BUG TRIBE LITADEINI, WITH THE DESCRIPTION OF THE NEW GENUS *STRAGULOTINGIS* (HEMIPTERA: TINGIDAE)

Richard C. Froeschner[1]

The tribe Litadeini was proposed for the genus *Litadea* by Drake and Ruhoff (1965a, p. 18) and defined by the unusual modification of the second tarsal segment: "Enormously swollen, nearly ovate in outline, upper surface convex, beneath deeply concave, the concavity filled with short, bristlelike hairs." Subsequently these two authors (1965b, p. 247) transferred *Holophygdon* Kirkaldy (1908, p. 364) from Tingini to Litadeini and described another genus, *Aeopelys*, as a member of Litadeini.

During preparation of a key to the genera of Tingidae of the world, it was found that on the basis of the modified second tarsal segment five more genera must be transferred from the tribe Tingini to the Litadeini (new assignments here): *Aristobyrsa* Drake and Poor (1937, p. 164), *Larotingis* Drake (1960, p. 357), *Oecharis* Drake and Ruhoff (1965b, p. 280), *Ogygotingis* Drake (1948, p.149), and *Psilobyrsa* Drake and Hambleton (1935, p. 148). In addition, two species cataloged in the Tingini genus *Pleseobyrsa* Drake and Poor have the modified tarsi of the Litadeini but do not fit well into any of the other genera and so must have a new genus erected for them.

The tribe Litaeini originally containing but one genus and species from the Indian Ocean island of Rodriguez, now includes thirteen species in nine genera and is almost Pan-Tropical in distribution. It is known from Africa and South America, and from the islands in the Indian (Rodreguez I.) and Pacific (Fiji and New Guinea) Oceans.

In view of the several genera added to the tribe Litadeini, the significant modifications of the second tarsal segment might profitably be reviewed and slightly modified. The segment is very strongly dilated at the base so that it is abruptly much wider than the first segment. The ventral surface is flat or concave (apparently arching inward during drying) and densely hairy with the hairs toward the sides of the segment much lengthened. The shape is not always broadly oval; in *Oecharis* it is elongate oval, tapering from the wide base to the slender claw-bearing apex. The functional significance of these modifications has not been investigated by observation of the living insect in the field.

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Stragulotingis, n. gen.

Fig. 1

Diagnosis: Within the tribe Litadeini, *Stragulotingis* is recognizable by the broad, flat, horizontal paranota associated with the flat discoidal areas.

Characters: Length 3.0-3.7 mm.; macropterus.

Head short, vertically deflexed, with 5 long, cephalic spines (occipital and supraclypeal pairs plus a median one above base of

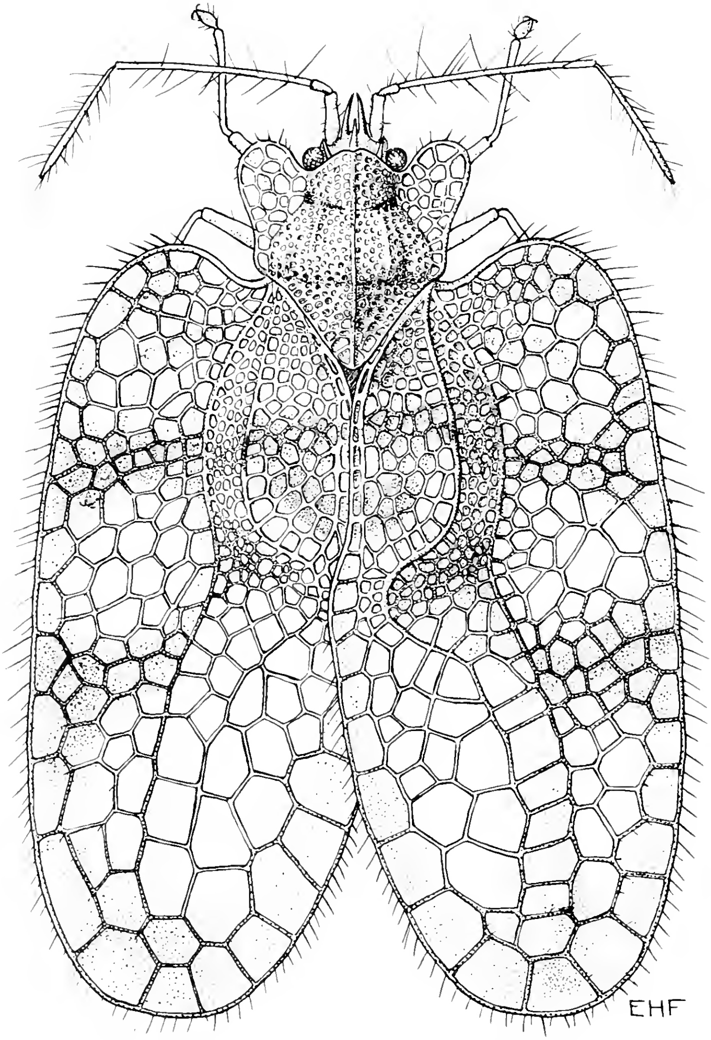

Fig. 1 *Stragulotingis plicata* (Champion)

latter); eye about one-third as wide as interocular space; bucculae short, not reaching apex of clypeus; labium extending onto apical half of mesosternum; antennae slender, cylindrical, all segments with long, slender bristles, segment I nearly or quite as long as interocular width, about three times as long as II, III slightly longer than I plus II, about one and a half times as long as IV.

Pronotum without inflated cysts; anterior margin convexly projecting almost to apex of head; median carina low, with a single row of small cells; lateral carinae reaching to calli, weak, lower than median carina, with cells obscure or absent; paranotum anterolaterally expanded obliquely, attaining a line across apex of head, lateral margins concavely converging posteriorly, terminating just posterior to humeral angles, anteriorly with long marginal bristles; posterior pronotal projection acute with apex narrowly rounded, extending to basal third of discoidal area.

Elytra conjointly nearly flat, multiseriate subcostal area oblique; outer margins, except basal half of sutural margin, with a row of numerous close-set, long tapering bristles; discoidal area reaching almost to midlength of elytron; costal margins strongly convex basally, extending distinctly cephalad of elytral articulation, thence straight and nearly parallel; costal area broad, horizontal, with 5-7 irregular rows of cells at widest point, surface transversely weakly depressed at basal fourth and midlength; sutural areas narrowly overlapping, leaving rounded apices widely separated; hypocostal lamina uniseriate, more or less remote from sides of abdomen.

Peritreme absent. Metapleural flange reduced, not expanded. Sternal laminae widely separated, strongly diverging on mesosternum, more widely separated and strongly outbowed on metasternum where their posterior apices are connected by a weak transverse carina. Abdomen convex basoventrally.

Type of genus: *Pleseobyrsa plicata* Champion, here designated.

Geographical distribution: The genus occurs in Tropical America from Costa Rica south to Brazil.

Comments: This genus admittedly is quite close to *Aristobyrsa* on a number of significant features, such as the long hairs of the antennae; the basal part of the costal area projecting convexly cephaled of the elytral articulation; the wide, anteriorly projecting paranotum; and the broad, coarsely lacey, diverging elytra. But two elytral features separate them. *Aristobyrsa* has the discoidal area very strongly, tumidly elevated and tilted outward to overhang the subcostal area, while *Stragulotingis* has the discoidal area low and flat. In addition, Aristobyrsa has the subcostal area vertical, much narrowed, subcoriaceous, with the veins much thickened and the included two rows of cells punctiform, while the subcosta on the two species of *Stragulotingis* is four to six cells wide with the veins and cells developed similarly to those of the discoidal area.

The prefix of the new name is from the Latin "stragulus" implying a spreading out and refers to the wide paranota and costal areas which expand anteriorly as well as laterally.

The two species included here were listed under the genus *Plese-obrysa* in the Drake and Ruhoff (1965a) catalog.

List of species of *Stragulotingis*

atratarsis (Drake and Hambleton), n. comb.
  Pleseobyrsa atratarsis Drake and Hambleton 1946b, p.124. Peru
plicata (Champion), n. comb.
  Leptobyrsa plicata Champion 1897, p. 26. Panama.
  Pleseobyrsa parana Drake and Hambleton 1944a, p. 95 [synonymy Drake and Ruhoff 1965a, p. 343]. Brazil.

Key to species of *Stragulotingis*

A. Tarsi black; size larger, length 3.6-3.7 mm. *atratarsis* (Drake and Hambleton).
  Tarsi yellow to tan; size smaller, length 3.0-3.2 mm. *plicata* (Champion)

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A NEW SPECIES OF *OPPIA* FROM COLORADO (CRYPTOSTIGMATA: OPPIIDAE)

Tyler A. Woolley[1]

A student brought in a soil and humus sample from a (commercial?) earthworm bed that was teeming with enchytraeids and uropodine mites. Associated with these organisms but not in such large numbers, was a species of one of the larger *Oppia*. Specimens of this species were compared with various species of this genus in the author's collections and with species described in the literature, particularly the species of the *Oppia* complex delineated by Hammer (1968). As a result of these comparisons, the species was determined to be a new representative of Oppiidae and is described below.

Oppia coloradensis, sp. n.

(Figs. 1-4)

Diagnosis. The new species resembles *Oppia trichosa* Hammer, 1958, and *O. notata* Hammer, 1958, as well as *O. yodai* Aoki, 1965, but the sensillus in each of these last three species is pointed and lanceolate rather than the blunt and slightly clavate type found in *O. coloradensis*, sp. n. Aoki's species also has five genital setae compared to four in *O. coloradensis*. The sensillus of the new species resembles the type found in *Amerioppia*, but the latter genus lacks interlamellar hairs, which are present in the new species. The rostrum of *O. notata* is pointed and has a transverse band with a small tooth; *O. trichosa* shows a rounded rostrum, as does *O. coloradensis*. In both *O. notata* and *O. trichosa* the interlamellar hairs are lacking, while in *O. coloradensis* these hairs are prominent. The new species also has similarity to *O. simplex*, Balogh, 1962, but the notogastral hairs of the latter species are much longer and more robust than in *O. coloradensis;* the notogastral hairs of *O. yodai* Aoki, 1965, are about the same relative length as in the new species.

Compared to *O. covarrubiasi* Hammer, 1968, from New Zealand, the new species has only four pairs of genital hairs (rather than six), the interlamellar hairs, exobothridial hairs and notogastral hairs of the new species are much longer.

The new species apparently lacks notogastral setae *ta* in all of the specimens examined.

Description. Golden-brown in color, with darker, reddish-brown margins; integument finely granlated on both prodorsum and notogaster; prodorsum triangular in outline, rostrum rounded, rostral hairs four-fifths as long as lamellar hairs, finely barbed; lamellae or lamellar ridges absent, lamellar hairs a fifth again as long as rostral hairs, finely barbed, decurved; dorsum between pedo-

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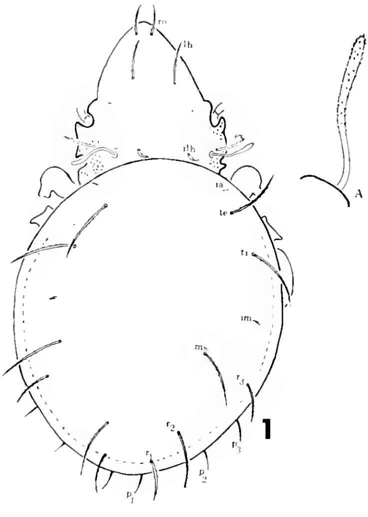

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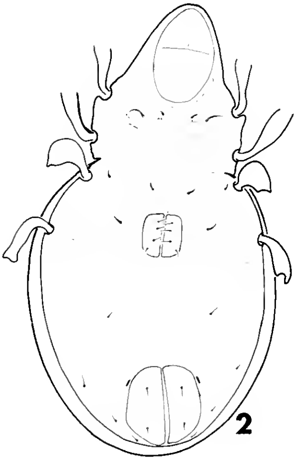

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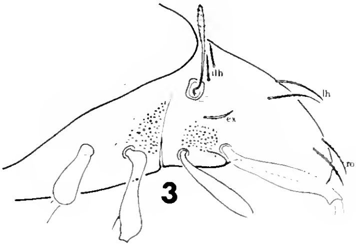

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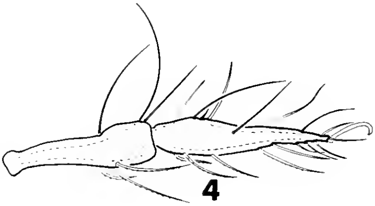

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Fig. 1. *Oppia coloradensis* from the dorsal aspect. legs omitted; A. enlarged view of sensillus.
Fig. 2. *O. coloradensis* from the ventral aspect, legs partially shown.
Fig. 3. Prodorsum and part of nonogaster of *O. coloradensis* from the lateral aspect, showing tubercles associated with bases of legs I-III and pedotecta I.
Fig. 4. Tibia and tarsus I of *O. coloradensis.*

tecta I with sculptured depressions or circles, interlamellar hairs shorter than rostrals, more robust, barbed; exobothridial hairs about as long as rostrals, but more definitely barbed; pseudostigmata small, circular; sensillus clavate, with fine spines or barbs (terminal barbs make the tip appear lanceolate, but the outline is clavate), curved outward, upward (position varies in mounted specimens), surface of head and two-thirds of pedicel barbed (Fig. 1A); prodorsal surface laterad of pseudostigmata finely tuberculated from pedotecta I to posterior margin, small, rounded tubercles extending into concavity of pedotecta I (Figs. 1, 3).

Outline of notogaster nearly round, slightly narrowed posteriorly, nine pairs of notogastral hairs present (setae *ta* appear to be missing in all specimens observed), main dorsal setae robust, curved, barbed, slightly longer than lamellar hairs; setae and fissures *ia*, *im* as in Fig. 1, fissure *im* equidistant between the setae *ti* and *ms*.

Camerostome oval, ventral apodemata, and setae as seen in Fig. 2; apodemata IV arched from behind insertion of legs IV to join the coxisternal apodeme anterior to genital aperture; genital aperture about ⅓ as large as anal, genital covers nearly rectangular, each with four setae, g:1-3 in nearly straight line nearer medial margin than lateral, g:4 in posterolateral corner of cover; aggenital setae, fissue *iad* and adanal setae as in Fig. 2; anal opening rounded, anal covers each with two setae.

Legs monodactylous

Measurements. Length 468 μ, prodorsum 162 μ, hysterosoma 324 μ; width 282 μ.

The type (a male), 10 male paratypes and 10 female paratypes were collected from a dirt sample with enchytraeids and uropodines, Fort Collins, Larimer County, Colorado, 1 December 1954, by T. A. Woolley; two additional females were taken from Mount Meeker Camp Ground, Boulder County, Colorado, 17 July 1952, by T. A. Woolley. The type will be deposited in the U. S. National Museum.

Dicussion. Hammer (1968) admits the difficulty of differentiating species of the "*Oppia*" complex, but she (1961, 1962, and 1968) evaluated and arranged species of this complex into a number of genera in a way that should be helpful; at least it is a start toward clarification of the complex. Admittedly, as Hammer indicates, *Oppia* continues to be an extraordinarily complicated genus or cryptically a series of genera, and the use of the genus *Oppia* (*sensu stricto* Koch) for species that do not fit in allied genera is resorted to, not as finally correct, but because the placement of such species in this genus is as close as one can come within the present taxonomic status of this group.

Hammer (1968) also delineates and provides a key for the genera of the *Oppia* complex in both South America and New Zealand. The North American representatives of this complex are little known in comparison. Higgins and Woolley (1965) described *Spinoppia magniserrata* as a new genus and species of this complex. Woolley (1957) also redescribed *Oppia minuta* (Ewing) from this group. Other representatives are known from North America, but no attempt has yet been made to assess the numbers of species and evaluate their placement in the current scheme of genera. The minute size of the representatives and the immense variety of forms are deterrants to a revision of this complex, even though such a revision and evaluation is sorely needed.

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A NEW GENUS AND SPECIES OF ORIBATID MITE (ACARI: LIACAROIDEA, METRIOPPIIDAE)[1]

Tyler A. Woolley[2]

About two years ago Dr. Henry Dybas very kindly sent me a number of collection of mites for sorting. Among the many oribatid specimens was one that slightly resembled *Pyroppia lanceolata* Hammer, 1955, but was larger (930 μ x 750 μ vs. 620-670 μ x 400 μ), and with different sensilli and lamellae. After comparing this mite with other known genera, I considered it to be a new genus and a new species in the family Metrioppiidae. It is described below.

Metapyroppia, n. gen.

Diagnosis. With spindleform sensillus, short lamellar cusps, an incomplete translamella; *Pyroppia* lacks a translamella and the sensillus is clavate-lanceolate. The large, straight, trochanteral setae of *Ceratoppia* and *Pyroppia* are apparently lacking in this new genus. The new genus differs from *Paenoppia* Woolley and Higgins, 1965, in the shorter lamellar cusps, the incomplete translamella and the spindleform sensillus; superficially, it resembles, yet differs from the oribatuloid *Conoppia* in the sensillus, the prodorsal hairs and six pairs of genital setae.

Type-species, *Metapyroppia doratosa* Woolley, monobasic.

Metapyroppia doratosa n. sp.

(Figs. 1, 2)

Diagnosis. The new species differs from *Pyroppia lanceolata* Hammer, 1955, in the barbed, spindleform sensillus, contrasting with the clavate-lanceolate sensillus of *P. lanceolata*; it differs also in the presence of transverse, prodorsal carina, in size and in the lack of trochanteral setae. The prefix *meta* implies "near" *Pyroppia*, and *doratos*, a spear-like sensillus.

Description. Color dark reddish-brown, prodorsum broadly triangular in outline; rostrum smooth, rostral hairs barbed, incurved, about as long as lamellar hairs, inserted in slight notches at antero-lateral margins of prodorsum (Fig. 1); a slight transverse carina anterior of lamellar cusps across surface of prodorsum; lamellae narrow, extending from dorsosejugal suture to bases of rostral hairs, attenuated anteriorly, lamellar cusps short, truncate, about as long as each end of interrupted translamella; lamellar hairs stout, barbed, nearly straight, about the same length as rostral hairs; translamella interrupted medially, short medial bar each side about as long as length of lamellar cusp; interlamellar hairs barbed, slightly longer

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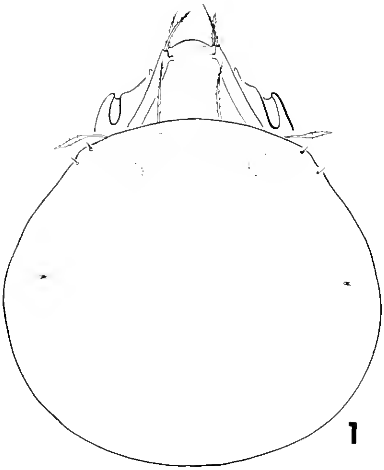

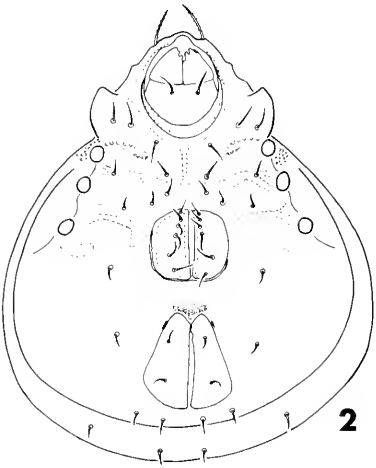

Fig. 1. Dorsum of *Metapyroppia doratosa*, legs omitted; hysterosoma broken in type specimen.

Fig. 2. Venter of *M. doratosa*, legs omitted.

than lamellar hairs, inserted mediad of bases of lamellae; pseudostigmata posterior to pedotecta I, slightly beneath hysterosomal margin; sensillus spindleform, barbed; pedotecta I stout, angled inward at anterior margin, forming lateral angles of broad triangular prodorsum.

Hysterosoma glabrous, nearly round in outline (slightly broken across dorsum of type specimen), with two humeral bristles posterior to pseudostigmata at shoulders of hysterosoma. Other setae and fissures as seen in Fig. 1.

Camerostome broadly oval, infracapitulum, ventral setae with prominent alveoli, and apodemata as seen in Fig. 2; trochanteral fossae II with slight tubercules on surface (like some other Liacaroidea); genital aperture nearly square, between insertions of legs IV, each genital cover with six setae, g:1-g:4 in nearly straight line near medial margin of cover, g:5 laterally displaced in posterior half of cover, g:6 near posterior margin, but not as close to medial margin as g:1-g:4; aggenital setae laterally placed at level of posterior margin of genital opening; anal aperture pentagonal, only slightly larger than genital aperture, each anal cover with two setae, a:1 in anterior half of cover, both anal setae about in middle of width of cover; preanal piece large, trumpet-shaped; *iad* fissure very narrow, almost indistinct, closely appressed to rim of anal aperture anterior to level of a:1; three pairs of adanal setae, ada:3 between levels of a:1 and a:2 but closer to a:1 and remote from anal openings by widest width of cover; ada:2, ada:1 posterior to anal opening.

Legs heterotridactylous; middle (empodial) claw only slightly larger than lateral (true) claws: stiff, straight seta of trochanter II (as found in *Ceratoppia* and *Pyroppia*) lacking.

Measurements. (As taken in broken type specimen) Length: 930 μ, prodorsum 180 μ, hysterosoma 750μ; width 726 μ.

Distribution. One female and type specimen was collected from moss on log on Mt. Le Conte, Sevier County, Tennessee, August 1956, by H. Dybas. The type will be deposited in the U. S. National Museum.

Discussion. This new genus and species represents yet another example of oribatid mites in the family Metrioppiidae. The characteristics of the sensilli, number of genital setae, tuberculous trochanteral fossae II are characteristics that ally these mites with the Liacaridae and Xenillidae in the Liacaroidea. It appears from research completed previously and some currently in progress that these families exhibit many characteristics in common. Delineations of the details of these comparative features and specifically demonstrable relationships await the results of further studies now in progress.

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A NEW SPECIES OF *LIACARUS* FROM A WOOD RAT NEST (ACARINA: CRYPTOSTIGMATA, LIACARIDAE)

Harold G. Higgins[1] and Tyler A. Woolley[2]

A number of different groups of mites are represented in the fauna found in rodent nests. Many of the mites are predaceous forms and the biotic relationships have not been explained fully. Others are parasitic forms that may have temporarily moved off their hosts (Daniel, 1969). Free-living oribatid mites are sometimes found in nests (Woolley and Higgins, 1968), but have been reported infrequently up to now. It is possible that these oribatids are natural inhabitants of the soil adjacent to the nests of the rodents and have migrated in, but they could also have been picked up from the soil and carried from nest to nest in the fur of the animals.

In the spring of 1969 a collection of mites taken from the sleeping nest of the Wood Rat (*Neotoma fuscipes*) was received from Mr. Tom Ashley of El Cajon, California. Among these was an undescribed species in the genus *Liacarus* as designated and summarized in the article of Woolley (1968). The new species has the barbed and spindleform sensillus typical of the genus, but specific differences separate it from known species.

Liacarus lectronus, sp. n.

(Figs. 1-3)

Diagnosis. The new species is most similar to *Liacarus robustus* Ewing, 1918, but is smaller in size and has a much smaller mucro, wider lamellae, pointed lamellar cusps and much longer interlamellar hairs. The trivial name comes from the Greek *lektron* implying "bed" and refers to the sleeping nest of the rodent from which it was taken.

Description. Color dark reddish-brown; prodorsum triangular, about a sixth as long as notogaster; rostrum notched, tip rounded; rostral hairs two-thirds as long as lamellar hairs, finely barbed, inserted in raised forward ridge of tutoria; lamellae broad, narrowed anteriorly, with bidentate cusps, medial dens twice as large as lateral dens; lamellar hairs about half as long as interlamellar hairs, inserted in dorsal surface of lamellae just behind anterior notch of lamellar cusp, finely barbed (Fig. 2); translamella with a prominent mucro extending from base of lamellae to level of insertions of lamellar hairs; interlamellar hairs twice as long as lamellar hairs, extended forward from insertions to level of tips of rostral hairs, finely barbed, inserted in medial margins of lamellae near dorsosejugal suture; pseudostigmata covered by clear, narrow shoulder patches of noto-

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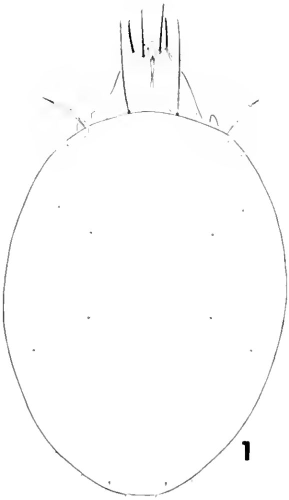

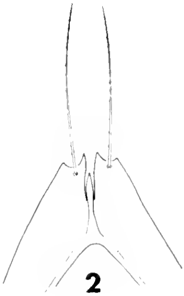

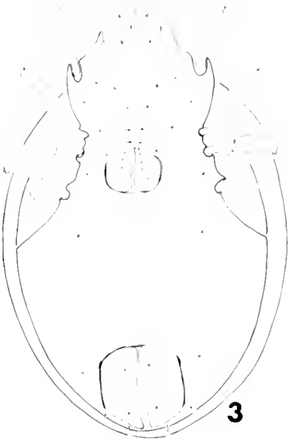

Fig. 1. *Liacarus lectronus*, from the dorsal aspect. legs omitted.
Fig. 2. *L. lectronus*, enlarged view of lamellae, mucro and lamellar hairs.
Fig. 3. *L. lectronus*, from the ventral aspect; legs partially omitted, but showing keeled femora I, II, III.

gaster, spiraled beneath surface; sensillus spindleform, finely barbed; pedotecta I with rounded tip.

Notogaster oval in outline; narrowed, clear shoulder patches extended over sensillus, with two fine, humeral bristles; ten pairs of fine notogastral setae visible in specimens (Fig. 1).

Camerostome oval, infarcapitulum diarthric; rutella, mentum, ventral setae and apodemata as in Fig. 3; genital opening smaller than anal; each genital cover with six setae, g:5 inserted more laterally than other setae on cover; aggenital setae widely separated, insertions closer to genital opening than to anal; anal opening nearly square, each anal cover with two setae inserted nearer medial margin than lateral; fissure *iad* and adanal setae as in Figure 3. ada:3 more remote from opening than ada:2 or ada:1.

Legs heterotridactylous; femora I, II, III each with fine pointed keel.

Measurements. The type female measures 702 μ x 438 μ.

Collection Data. Three specimens, two females and a male, were collected from the sleeping nest of *Neotoma fuscipes*, 20 March 1968, at Cuyanaca Reservoir, San Diego Co., California, by Tom Ashley. The type will be deposited in the U. S. National Museum. The paratypes will be retained by the authors.

Discussion. In the same collection with *L. lectronus*, sp. n. from the *Neotoma* nest was another species that has been recorded from Europe previously, but not from the United States.

This unusual find consisted of four specimens of *Cosmochthonius reticulatus* Grandjean, 1947. Although several species of *Cosmochthonius* are reported from Europe, South America, and New Zealand, to our knowledge this is the first time that this European form has been reported from the United States.

Preliminary studies indicate that studies of rodent nests in the future may disclose a source of desert forms of oribatids that is currently untapped.

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INVASION OF A "TRAPPED-OUT" SOUTHERN NEVADA HABITAT BY *PEROGNATHUS LONGIMEMBRIS*

Lester D. Flake[1] and Clive D. Jorgensen[2]

Abstract: A 6.3 ha grid was established at the United States Atomic Energy Commission's Nevada Test Site and the small mammals trapped-out during the summers of 1964 and 1965 to study invasion by *Perognathus longimembris* Coues. Age analyses were made to determine the relationship between age and invasion. The mean age of invading animals was lowest in mid- and late summer, but varied widely with reproductive success. There was no statistically significant difference in mean age between male and female invaders. Ratios of male to female invaders varied directly with that of the natural population. Invasion rates varied widely and were mainly influenced by population density outside the grid.

Introduction

Small mammal invasion studies of "trapped-out" habitats are not numerous; but rates of invasion, home site origin, relationship of invasion behavior to population density, juvenile or adult classification of invaders, and sex ratios of invaders have been examined for several species by Andrzejewski (1963), Andrzejewski and Wroclowek (1962), Blair (1940), Calhoun and Webb (1953), Stickel (1946) and Webb (1965). These studies were made in non-arid environments and did not include any of the heteromyid rodents.

In this study a "trapped-out" habitat was created and *Perognathus longimembris* Coues movement into the grid (invasion) examined. Special attention was given to age composition of invading *P. longimembris*. The possibility that male and female invaders come from different age groups was examined along with sex ratios and rates of invasion. These analyses provide the basis for determining how the population characteristics of *P. longimembris* affect its invasion behavior.

Materials and Methods

The study was conducted at the United States Atomic Energy Commission's Nevada Test Site, 70 miles northwest of Las Vegas, Nevada. The study area was in relatively undisturbed Grayia-Lycium community (Allred, Beck and Jorgensen, 1963) in the northeast portion of Yucca Flat.

A 6.3 ha grid was established with 12 parallel transects placed at 22.9 m intervals. Each transect contained 12 trapping stations 22.9 m apart. Two Young-type live traps were placed at each of the 144 trapping stations.

Small mammals were trapped and removed daily from June 7 through Aug. 25, 1964, and from June 9 through Sept. 7, 1965. Small mammals were removed and traps baited with small amounts of

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rolle doats prior to 9:00 a.m. each day. Animals were killed and taken to the laboratory where age and sex were determined.

During Aug. 1965, three 460 m transects, 100 m apart, were established three miles southwest of the grid to sample the untrapped population for mean age. Fifty equally spaced Museum Special traps were placed on each transect and operated for seven nights between Aug. 15 and Sept. 7. All *P. longimembris* were taken to the laboratory for age and sex determinations.

The tooth wear technique developed for *Perognathus* by Howard Kaaz (University of California, Los Angeles, California, unpublished data) was used for age determination. A key for this technique and accompanying illustrations are included in Flake (1966).

RESULTS

The number of *P. longimembris* trapped daily leveled off by the sixth day after trapping began in 1964 and those trapped after that were considered to be invaders. Numbers of *P. longimembris* trapped per day for the first 10 days of trapping in 1964 were respectively: 39, 15, 32, 15, 22, 16, 4, 7, 4 and 2. In support of the above observation it was found that after the fifth day of trapping, almost all captures were within 68.7 m of the borders. Similar results were obtained during the first six trapping days of 1965.

Mean ages of *P. longimembris* for the trapping-out periods and subsequent invasion periods are presented in Table I. Table II gives the mean age by sex and period of capture. Hereafter, the June 7-11, June 13-30, July 1-31 and Aug. 1-25, 1964, periods; and the June 9-13, June 15-30, July 1-31 and Aug. 15 - Sept. 7, 1965, periods are referred to as the 1st, 2nd, 3rd and 4th periods for the respective years. June 7-11, 1964, and June 9-13, 1965, are actually trapping-out periods while all other trapping intervals represent, by definition, invasion periods.

An analysis of variance of the age data, using the fixed effects model (model I), disclosed statistically significant differences (P - .05) in the main effect means for the years x periods interaction. The years x sex, periods x sex, and years x periods x sex interactions were not significant. Mean age comparisons within the years x periods interaction were accomplished with Cramer's modification of Duncan's multiple range test (Cramer, 1956). Use of the expression "significant difference" throughout the papers refers to a statistically significant difference at the 5 percent level.

Comparison of mean ages for 1964 and 1965 trapping periods (Table I) yielded the following results. In 1964 and 1965 there was no significant difference between means for the 1st and 2nd periods within either year. For both years there was a significant difference between the mean for the 1st period and the means for the 3rd and 4th periods. Similarly, there was a significant difference between the mean for the 2nd period and the means for the 3rd and 4th periods in both years. No significant difference was observed between the means for 3rd and 4th periods within years. There was no significant difference in 1st and 2nd period means between years, but there was a significant difference in means for the 3rd and 4th periods between years. In summary, the mean age of invaders decreased from early to late summer in both 1964 and 1965 though the decrease was much greater in 1965.

As noted previously, *P. longimembris* were trapped from an untrapped population three miles southwest of the grid between Aug. 15 and Sept. 7, 1965. The mean age ($n = 88$, $x = 4.6$ months, $s = 7.9$ months was not significantly different from that of period 4, 1965, grid invaders (Table I).

The ratios of males to females for the trapping periods are given in Table I. In 1964, there were 1.3 males per female captured during period 1 (trapping-out period). Since reproduction was negligible in 1964 (French, Maza and Aschwanden, 1967), the sample ratio for the 1st period may be used to estimate the sex ratio in the untrapped population outside the grid. Among total invaders for 1964, 1.5 males invaded per female. A chi-square test disclosed no significant difference in proportion of males to females between the period 1 estimate of the untrapped population and total invaders ($X^2_{(1\ \text{df},\ .05)} = .08$. In 1965 among total invaders 0.8 males invader per female. When the proportion of males among total invaders was compared with that for *P. longimembris* trapped three miles southwest of the grid from Aug. 15 to Sept. 7 ($n = 88$, 42 males, 46 females), no significant difference was found $X^2_{(1\ \text{df},\ .05)} = .01$).

Invasion rates varied from one period to the next as well as between 1964 and 1965 (Table 1). One may question the high invasion rate from Aug. 15 to Sept. 7, -965, since the grid was not trapped the two previous weeks. The daily trapping records (Flake, 1966) show that the largest numbers per day were observed during late August and early September rather than mid-August. If there had been extensive invasion and settlement during the two weeks when there was no trapping, the highest trapping incidence would be expected to occur early after trapping was resumed. These data suggest the increase in rate was mainly due to invasion and not belated capture.

Discussion and Conclusion

Reproductive activity and its relationship to the environment is an essential consideration in understanding age distribution and invasion. Hall (1946) reported that *P. longimembris* have one litter per year and noted pregnancies from early April through June. Duke (1957) stated that *Perognathus* in Utah may have two litters each year and that pregnancy is possible between early April and early June. Speth, Pritchett, and Jorgensen (1968) found that *Perognathus parvus* in southern Idaho may have two litters per year and suggested that the number of litters depends on food availability. At the Nevada Test Site, French, Maza and Aschwanden (1967) reported extremely low rainfall and poor plant growth in the winter and spring of 1962-63 and 1963-64. They found essentially no *P. longimembris*

Table 1. Summary of *Perognathus longimembris* trapped inside the study grid

Trapping Period	Trap Period	Number of Animals	Mean Age (Months) ± ISD	Ratio of Males to Females	Invasion Rates (Animals/day)
1964					
June 7 to 11*	1	128	22.1 ± 8.9	1.3	
June 13 to 30	2	64	20.8 ± 10.6	1.2	3.6
July 1 to 31	3	28	16.0 ± 11.4	3.0	.9
Aug. 1 to 25	4	27	14.7 ± 11.5	1.2	1.1
Total 1964 Invaders	2, 3, 4	119	18.4 ± 11.3	1.5	1.6
1965					
June 9 to 13*	1	38	21.6 ± 10.2	0.7	
June 15 to 30	2	4	18.0 ± 8.9	1.0	.3
July 1 to 31	3	34	4.4 ± 6.4	1.4	1.1
Aug. 15 to Sept. 7	4	596	3.3 ± 3.3	0.8	24.8
Total 1965 Invaders	2, 3, 4	634	3.5 ± 3.9	0.8	8.9

*Trapping-out period

Table 2. Mean ages in months (± std dev) by sex of *Perognathus longimembris* for 1964 and 1965 trapping-out periods.

1964

Sex	June 7-11 (Period 1)	June 13-30 (Period 2)	July 1-31 (Period 3)	Aug. 1-25 (Period 4)	June 13-Aug. 25 (Periods 2, 3. & 4)
Male	20.2 ±8.6 (73)*	20.3 ±10.4 (35)	15.1 ±11.1 (21)	15.2 ±10.6 (15)	17.7 ±10.9 (71)
Female	24.8 ±9.4 (55)	21.9 ±10.7 (29)	20.7 ±12.0 (7)	14.1 ±13.1 (12)	19.8 ±11.8 (48)

1965

Sex	June 9-13 (Period 1)	June 15-30 (Period 2)	July 1-31 (Period 3)	Aug. 15-Sept. 7 (Period 4)	June 15-Sept. 7 (Periods 2. 3. & 4)
Male	23.6 ±9.9 (16)*	24.0 ±2.8 (2)	5.6 ±8.3 (20)	3.5 ±4.1 (265)	3.8 ±4.1 (287)
Female	20.1 ±10.4 (22)	21.0 ±14.8 (2)	2.8 ±1.2 (14)	3.0 ±2.4 (331)	3.1 ±2.7 (347)

*Number of observations

reproduction in the summers of 1963 and 1964. When conditions improved for plant growth in the winter and spring of 1964-65, they noted rapid population growth the following summer. During this period they found several individual *P. longimembris* living from 2 to 5 years in the field. Jorgensen (Brigham Young University, Provo, Utah, personal communication) also noted that several *P. longimembris* survived at least 3 years in the field at the Nevada Test Site.

The relatively high mean age of animals trapped in 1964 and June of 1965 probably reflects extremely poor reproduction in the summers of 1963 and 1964. Thus, a mean age of 22 months (June of both years) is not unreasonable considering the extremely limited addition of young to the population during and prior to trapping. The difference in mean age of 3rd and 4th period invaders between years is likely a reflection of poor reproduction in 1964 versus increased reproduction in 1965. The decrease in mean age through both summers correlates well with appearance of young in the population and reproduction success.

There was no significant difference in the mean age of male and female *P. longimembris* invaders (Table II) and no significant interaction involving sex; therefore, the sexes were treated as a single group in age analysis.

As there was no significaant difference between age of animals in the untrapped population (3 miles southwest of the grid) and 4th period invaders for 1965, it could not be concluded that young animals have a greater tendency to invade than adults. The mean age of the untrapped population was extremely small $x = 4.6$ months, $s = 7.9$ months), probably because of high reproductive success. Hence, a preferential invasion by young *P. longimembris* probably would not have been detectable.

Stickle (1946) observed that adult *Peromyscus leucopus* invading a "trapped-out" grid consisted of 2 males per female while the natural population in the immediate area contained approximately equal numbers of males and females. In the present study of *P. longimembris*, males invading the study grid outnumbered females in 1964 and similar ratios were obtained within the grid's original population (trapping out period) which was used to estimate the ratio in the untrapped population. Contrary to the 1964 results, females invaded more frequently than males in 1965. In 1965, the sex ratio of *P. longimembris* from the untrapped population 3 miles southwest of the grid was compared with that in the study grid and ratios of males to females for both samples were almost identical. These results indicate the sex ratios of invading *P. longimembris* are approximately the same as those in the natural population.

The rates of invasion are likely influenced by several population characters. Stickle (1946) noted that *Peromyscus* with home ranges overlapping the borders of a newly established void were first to invade. Andrezejewski and Wroclowek (1962) concluded that the rates of invasion of *Apodemus* and *Clethrionomys* were determined by the density of the adjacent population, and further Andrzejewski (1963) stated that increased rates of invasion and settling during the midsummer were due primarily to emergence of young and subsequent increase of density.

In this study, the highest invasion rate in 1964 occurred from June 13 to 30 and was possibly the result of the rapid removal of animals with home ranges overlapping or adjacent to the grid. Since reproduction during 1964 was extremely poor, the invasion rate remained low through the summer. In 1965 the low density in the surrounding population (resulting from the 1964 low reproduction) resulted in low invasion rates in June and July but the rate increased greatly in August and September as the numerous young increased the density of the surrounding population.

ACKNOWLEDGEMENTS

This study, No. C00-1336-2, was supported in part by U. S. Atomic Energy grant (AT(11-1)1336 to Brigham Young University, Provo, Utah. The preparation of this manuscript was supported in part by NIH Training Grant No. T01-ES00089 from Division of Envioronmental Health Sciences, Bureau of State Services, U. S. Public Health Service. The age determinations were made possible with the aid of Howard Kaas at the University of California, Los Angeles, who has developed the method of tooth wear age analysis for *Perognathus*. Dr. Vincent Schultz (Washington State University, Pullman, Washington) assisted in statistical analysis of the data.

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CRAMER, C. Y. 1956. Extension of multiple range tests to group means with unequal numbers of replications. Biometrics. 12(3):307-310.

DUKE, K. L. 1957. Reproduction in *Perognathus*. J. Mammal, 38(1):207-210.

FLAKE, L. D. 1966. Small mammal invasion of a trapped-out habitat. Master's thesis. Brigham Young Univ., Provo, Utah. 35 pp. (unpublished).

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HALL, E. R. 1946. Mammals of Nevada. University of California Press, Berkeley. 710 pp.

SPETH, R. L., C. L. PRITCHETT, AND C. D. JORGENSEN. 1968. Reproductive activity of *Perognathus parvus*. J. Mammal. 49(2):336-337.

STICKEL, L. F. 1946. The source of animals moving into a depopulated area. J. Mammal. 27(4):301-307.

WEBB, W. L. 1965. Small mammal populations on islands. Ecology 46(4): 479-488.

LIST OF THE INSECT TYPE SPECIMENS IN THE ENTOMOLOGICAL COLLECTION OF THE BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH No. III.

Vasco M. Tanner[1] and Don R. Harris[2]

In 1935 and 1936 Lists of Insect types in the Entomological Collection of Brigham Young University were published.[3] Since then there has been added to the University Entomological Collection the following type specimens in the order Coleoptera. Lists of type material in other orders will shortly be published. All type specimens are segregated from the main research insect collection. These are available to competent students of the insects.

ORDER COLEOPTERA

FAMILY CICINDELIDAE

Amblycheila utahensis Tanner.
Great Basin Nat. XI. (1-2):47, 1951.
Type; Diamond Valley, Washington Co., Utah. (Richard Schmutz)

Cicindela parowana platti Cazier.
Southern Calif. Acad. Sci., Bull. 35:161, 1937.
1 paratype; Bentons Crossing, Mono Co., Calif.; 12 Aug. 1936.

FAMILY CARABIDAE

Elaphrus torreyensis Tanner.
Great Basin Nat. VI. (4):137, 1941.
Paratype; Torrey, Wayne Co., Utah, June 1938, (W. W. Tanner)

Brachinus pulchellus Blatch.
The Coleop. of Indiana, Bull. 1, Indiana Dept. Geol. & N. R. :161, 1910.
1 paratype; Posey Co., Ind., 4-11-01 (W. S. Blatchley).

FAMILY AMPHIZOIDAE

Amphizoa carinata Edwards.
Wasmann Journ. Biol., 8(3):326. 1950.
4 paratypes; Near Cameron Pass, Gould, Colo; 18-20 Aug. 1941, (Vasco M. Tanner)

FAMILY OMOPHRONIDAE

Omophron (*Homophron*) *tanneri* Chandler.
Great Basin Nat. 2(2):100, 1941.

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[2] Graduate student in Entomology, Brigham Young University.
[3] Utah Academy of Sciences, Arts, and Letters (Vol. XII), p. 181-193; Utah Academy of Sciences, Arts, and Letters (Vol. XIII), p. 147-152.

Holotype and allotype: Moab, Utah 1927 (Irvin Rasmussen).
36 paratypes; Moab, Utah, June 1927, (James Kartchner, Anson Call, Jr., Vasco M. Tanner, and Irvin Rasmussen).

Omophron (*Homophron*) *tanneri proximum* Chandler.
Great Basin Nat. 2(2):102, 1941.
Holotype and allotype; Escalante River, Garfield Co., Utah, Mouth of Calf Creek, 2 Aug. 1939 (H. P. Chandler).

FAMILY DYTISCIDAE

Coelambus salinarius Wallis.
Can. Ent., 56:105
1 paratype; Baldur, Man.; 29-VII-22, (J. B. Wallis).

Hydroporus transpunctatus Chandler.
Great Basin Nat., 2(2):103-104, 1941.
Holotype; Aspen Grove, Utah Co., Utah, 1 Aug. 1938 (H. P. Chandler).

Agabus colymbus Leech.
Can. Ent., 70:125, 1938.
1 paratype; Churchill, Man. VII-7-1937; (W. J. Brown).

FAMILY MELYRIDAE

Eutrichopleurus concinnus Blais.
Tr. Amer. Ent. Soc., 66:321, 1940.
1 paratype; St. George, Washington Co., Utah, V-28-35 (E. C. Van Dyke).

FAMILY MELOIDAE

Epicauta normalis Werner
Psyche, 50:65, 1944.
6 paratypes; Fillmore, Utah (D. E. Johnson); Sheep Creek, Duchesne Co., Utah; June 1926 (Vasco M. Tanner); Provo Environs, Utah, (Truman Swallow).

FAMILY BUPRESTIDAE

Acmaeodera parkeri Cazier.
Wasmann Colr., 4:22, 1940.
1 paratype; Globe, Arizona, 7 Sept. 1936 (F. H. Parker).

Acmaeodera ligulata Cazier.
Wasmann Colr., 4:20, 1940.
1 paratype; Graham Mts., Arizona, 21 June 1935 (D. K. Duncan).

Acmaeodera duboisi Cazier.
Bull. So. Cal. Ac. Aci., 37:138, 1938.
2 paratypes; Death Valley, Furnace Creek, Co., California, 14 April 1938.
Santa B. Co., California, 4 July 1938 (B. E. White) (*Prosopis juliflora glandulosa*).

Acmaeodera holsteni White.
Pan. Pac. Ent. 15:71, 1939.
2 paratypes; Sunset Valley, Santa B. Co., California, 4 July 1938. (B. E. White). (*Adenostoma fasiculatur*).

Acmaeodera adenostomae Cazier.
Bull. So. Cal. Ac. Sci., 37:127, 1938.
1 paratype; Pasadena, California, 22 May 1925.

FAMILY TENEBRIONIDAE

Eschatomoxys tanneri Sorenson and Stones.
Great Basin Nat., 19 (2 and 3):63-66, 1959.
Holotype, allotype, 8 paratypes.
Crossing of the Father, Colorado River, Kane Co., Utah, 5-8-1959. (E. Sorenson and R. Stones).

Craniotus blaisdelli Tanner.
Great Basin Nat. 23 (3-4) :167-170, 1963.
Type and 3 paratypes; Inyo Mts., California, 18 April 1949, (Owen Bryant); Nevada Test Site, Nye Co., Nevada

Araeoschizus airmeti Tanner.
Great Basin Nat., 6(1-4):125-26, 1945.
Type and 9 paratypes; Nampa, Idaho, April 1944 (LeRoy Jack Airmet).

Eleodes lineata Blaisdell.
Trans. Am. Ent. Soc., 64:55, 1939.
2 paratypes; Chiricahua Mts. Arizona, 5 Aug. 1933, (Owen Bryant) Lot #417.
2 paratypes; (Owen Bryant), Lot #33-448, Chiricahua Mts. Ariz., 23 June 1933. Elevation 6,000'.

Eleodes omissa pygmaea Blaisdell.
United States Nat. Mus. Bull. 63; 77, 1909.
5 plesiotypes; San Diego, California.

Eleodes leechi Tanner.
Geat Basin Nat., 21(3):63, 1961.
7 paratypes; 3-Moab, Utah June 1927 (Anson Call, Jr.; 2-Cortez, Colo.: 2 May 1925; 1-Blanding, Utah (W. J. Gertsch); 1-La Sal, Utah June 1927, (Irvin Rasmussen).

Eleodes inyoensis Tanner.
Great Basin Nat. 21(3):68, 1961.
23 paratypes; Saline Valley, Inyo Co., California, 1-11 Nov. 1959 (B. H. Banta).

Eleodes dentipes sub sp. *sordida* Blais.
Can. Ent. 67:30, 1935.
1 paratype; Tulare Co., California.

Eleodes novoverrucula Boddy.
Pan. Pac. Ent., 33(4): 195, 1957.
2 paratypes: 1 Pullman, Washington, 27 May 1907, 1-Coeur d' Alene, Idaho, June (Wickham).

Eleodes (*Metablapylis*)*californica* Blais.
Pan. Pac. Ent., 4(4) 1965, 1929.
1 paratype; Pal mSprings, Riverside Co., California, 10 Mar. 1925 (E. C. Van Dyke).

Eleodes (*Holeleodes*) *bryanti* Blais.
Tr. Amer. Ent. Soc. 63:137, 1937.
1 paratype; Graham Mts., Ariz., 12 Aug. 1933, (Owen Bryant), Lot #294.
8 topotypes determined by Blaisdell; collected 10-25 Sept. 1937, at 7400' and 9700' (Owen Bryant).

Lariversius tibialis Blais.
Pan. Pac. Ent. 23:59-62, 1947.
2 paratypes; Pyramid Lake, Nevada; 24 Aug. 1941 and 1 Sept. 1940; sand dunes (Ira LaRivers).

Alaephus nevadensis Tanner.
Brigham Young Univ. Sci. Bull.; Biol. Ser. 6(1):39, 1965.
Type and 4 paratypes; Nevada Test Site, Mercury, Nye Co., Nevada, 25 July 1961.

FAMILY SCARABAEIDAE

Serica pruinosa Saylor.
J. Ent. & Zool. 27:2, 1935.
1 paratype; July 1933; Colinga, Kings Co., California.

Diplotaxis brevicornis Cazier.
Great Basin Nat. 1:136-37, 1940.
1 paratype; Pyramid Peak, Dona Ana Co., New Mexico, 12 Aug. 1930 (F. R. Fesberg).

Diplotaxis impressifrons Cazier.
Great Basin Nat. 1:127, 1940.
1 paratype; Cedarville, Modoc Co., Calif., 20 May 1939 (P. C. Ting, M. A. Cazier, J. A. Downes, T. Aitkens).

Coenonycha tingi Cazier.
So. Calif. Acad. Sci., Bull. 37:126, 1937.
2 paratypes; ♂ and ♀, Nepa, Nepa Co., Calif., 20 March 1937, (H. R. Leech, M. Cazier), (*Adenostoma fasciculatum* H. and A.).

Coenonycha ampla Cazier.
Amer. Mus. Nov. 12 39:14, 1943.
1 ♂ paratype; Coalings, Calif., 20 Mar. 1940 (K. S. Hagen).

Coenonycha testacea Cazier.
So. Calif. Acad. Sci., Bull. 36:127, 1937.

2 paratypes: ♂ and ♀. Clear Creek. Cuyama Canyon, Calif., 7 Mar. 1937 (E. Ross. H. B. Leech. M. Cazier). (*Erigonum*).

Coenonycha hageni Cazier.
Amer. Mus. Nov. 1239:15. 1943.
2 paratypes; ♀. seven miles West Coalinga. Fresno Co., Calif. 20 Mar. 1940 (R. G. Dahl) (*Erigonum fasciculatum Benth*). ♂. Coalings. California. 14 May 1938 (M. Cazier), (*Erigonum fasciculatum Benth*).

Coenonycha barri Cazier.
Amer. Mus. Nov. 1239:19. 1943.
1 paratype; McKittrick, Calif., 21 Mar. 1940 (K. S. Hagen).

Phobetus palpalis Saylor.
J. Ent. & Zool. 28:1. 1936.
1 paratype; Indio, Calif., 24 Mar. 1935 (F. R. Platt).

FAMILY CHRYSOMELIDAE

Exema byersi Karren.
Univ. Kansas Sci. Bull., 46:670-72.
2 paratypes: eight miles North Lawrence. Kansas. 8 July 1965, (J. B. Karren) (taken on *Gutierrez dracunculoides*).

Exema mormona Karren.
Univ. Kansas Sci. Bull., 46:659-672.
3 paratypes; One Farr West, Utah (C. J. D. Brown), 2 Hobble Creek Canyon. Uinta National Forest. Utah. 16 Aug. 1961, (S.L. Wood. J. B. Karren) (*Gutierreza sarothae*).

FAMILY ANTHRIBIDAE-PLATYSTOMIDAE

Brachytarsus annulatus Carr.
Can. Ent., 60:279. 1930.
1 paratype; Medicine Hat. Alberta. Canada, 1930 (F. S. Carr).

Brachytarsus beyeri Schaeffer.
Trans Amer. Ent. Soc. 32:277, 1906.
8 cotypes; California.

FAMILY CURCULIONIDAE

Hyperodes interpunctatulus Dietz.
Amer. Ent. Soc., Trans. 16:36. 1881.
1 paratype; Cypress Mills. Texas (Schaupp).

Listronotus leechi Sleeper.
Pan. Pac. Ent. Vol. 31(3):156. 1955.
2 paratypes: Rawlings Lake. Lumby B.C. 3 Oct. 1946, (Hugh B. Leech).

Lepyrus oregonus tesselatus Van Dyke.
Pan. Pac. Ent., 5:56. 1928.
1 paratype; Banff. Alta.. 13 June 1928 (Owen Bryant).

Pantomorus peregrinus Buchanan.
U.S. Dept Agric. Misc. Pub. #341:14. 1939.
4 paratypes: 3-Gulfport, Mississippi, 3 Sept. 1937. (Gladney and Padgett); 1-Saucier, Mississippi, 3 Sept. 1937 (Dopson, Padgett, Baker).

Pantomorus planitiatus Buchanan.
U.S. Dept. Agri. Misc. Pub. #341:36. 1939.
2 paratypes; Pueblo, Colo., (H. Soltau Collection).

Orchestes pallicornis var. *pallidior* Leng.
Rhynchophora of North Eastern America, Indianapolis, p. 281, 1916.
Type and 4 paratypes; Nfld., July.

Pandeleteius bryanti Tanner.
Great Basin Nat.,14:76. 1954.
Holotype, allotype, 3 paratypes; Davis Mts., Texas, 9 May 1941. Owen Bryant, 6,700'.

Dorytomus rubidus Tanner.
Great Basin Nat., 1(1):23, 1939.
Type; St. George, Utah, 20 April 1934 (V. M. Tanner).

Lupinocolus blaisdelli Van Dyke.
Pan. Pac. Ent. 12:82. 1936.
1 paratype; Hope Valley, Eldorado Co., California, July.

Endalus laticollis Blatchley.
Rhynchophora of N. E. America, Indianapolis. 1916.
1 cotype; Dunedin, Florida, 15 March 1913 (W .S. Blatchley). 3 topotypes from Leng Collection.

Endalus depressus Burke.
The Southwestern Nat. 6(2):65-72. 1961.
2 paratypes; Anderson Co., Texas, 31 Aug. 1958 (H. R. Burke).

Lixellus haldemani Burke.
Southwestern Nat., 8:167-168, fig. 6. 1963.
2 paratypes; College Station, Brazos Co., Texas, 5 and 13 May 1962 (H. R. Burke).

Onychylis essigi Tanner.
Great Basin Nat., 14:77-78, 1954.
4 paratypes; Saratoga Springs, Death Valley, California, 20 March 1944 and 23 April 1944. (J.N. Belkin).

Onychylis texanus Burke.
Coleop. Bull. 13:36-37, 1959.
2 paratypes; Anderson Co., Texas, 31 Aug. 1958 (H. R. Burke).

Pseudoeucyllus boulderenis Tanner.
Great Basin Nat. 10:71-72, fig. 1, 1950.
Holotype; Boulder Dam, Arizona (V. M. Tanner).

Eugnamptus nigriventris Schaeffer.
Bull. Br. Inst. I. pp. 141-179. 1905.
1 cotype; Huach. Mts., Arizona. Aug.

Eugnamptus pallidus Schaeffer.
Journ. N.Y. Ent. Soc. XVI. p. 213. 1908.
2 cotypes: Huach. Mts., Arizona.

Eupagoderes bryanti Van Dyke.
Pan Pac. Ent., 27:31. 1951.
4 paratypes; Baboquivari Mts., Arizona. 20-24 Sept. 1933, (Owen Bryant).

Eupagoderes simulans Van Dyke.
Pan. Pac. Ent., 10(4):176-177, 1934.
1 paratype; Allamore, Texas, 2 July 1930 (J. O. Martin).

Eupagoderes californicus Ting.
Bull. So. Calif. Acad. Sci., 38:81-83, 1939.
1 paratype: Stove Pipe Wells, Death Valley, California, 13 April 1938 (J. J. DuBois).

Eupagoderes hardyi Tanner.
Great Basin Nat., 1:31-32, 1939.
Type: North Fork Provo Canyon, (D. Elmo Hardy).

Eupagoderes utahensis Tanner.
Great Basin Nat., 1:31, 1939.
Type: St. George, Utah, (Vasco M. Tanner).

Tosastes columbianus Van Dyke.
Pan. Pac. Ent., 27:32, 1951.
2 paratypes; 1-Kamloops, B.C. 1 May 1932. (Owen Bryant).

Cimbocera buchanani Ting.
So. Calif. Acad. Sci. Bull.,39:134, 1940.
1 paratype: San Marcial, Socorao Co., New Mexico, 22 June 1921 (C. D. Duncan).

Cimbocera petersoni Tanner.
Great Basin Nat., 2:29-30. figs. 1, 2, 1941.
♀ holotype, ♂ allotype, ♀ 11 paratypes, 3 ♂ paratypes, Virgin River, Utah, (Weidt); 6 ♀ paratypes, St. George, Wash. Co., April, 1921, (Vasco M. Tanner); 1 paratype; Washington, Wash. Co., Utah (Vasco M. Tanner) ; 1 ♀ paratype; Indianola, Sanpete Co., April 1921 (Vasco M. Tanner).

Paracimbocera atra Van Dyke.
Pan. Pac. Ent., 14:2, 1938.
1 Topotype: Mt. Charleston, Less Canyon, Clark Co., Nevada, 24 May 1960 (W. Reeves, M. Cazier, P.C. Ting), determined by P. Ting 1941.

Paracimbocera artemisiae Ting.
Bull. So. Calif. Acad. Sci., 39:39, 1940.

1 paratype; Esmeralda Co., Nevada, 15 Oct. 1907 (F. W. Nunenmacher).

Miloderes argenteus Van Dyke.
Pan. Pac. Ent., 11:4. 1935.
1 ♂ paratype; Paonia, Delta Co., Colo., 18 June 1926 (E. C. Van Dyke).

Miloderoides vandykei Tanner.
Great Basin Nat., 3:23-24. 1942.
Holotype, allotype, and 3 paratypes; Virgin River, Utah (Weidt).
2 paratypes; St. George, Utah (A. M. Woodbury).

Miloderoides maculatus Van Dyke.
Pan. Pac. Ent., 12:72. 1936.
1 paratype; Parma, Idaho, 28 April 1932.

Cryptolepidus leechi Ting.
Bull. So. Calif. Acad. Sci., 39:147. 1940.
1 paratype; Baker, California (P. C. Ting, M. Cazier, H. Leech). (*Atriplex* sp.).

Cryptolepidus rugicollis Ting.
Bull. Calif. Acad. Sci., 39:149. 1940.
1 ♀ paratype; 3 miles north of Lovelock, Nevada, 17 May 1938 (*Atriplex* sp.).

Cimbocera cazieri Van Dyke.
Pan. Pac. Ent., 12:73. 1936.
1 paratype, Baker, California, 27 March 1935 (M. Cazier).

Cryptolepidus aridus Tanner.
Brigham Young Univ. Sci. Bull., Biol. Ser. 8(2):11-12. Figs. 5, 6, 7. 1966.
3 paratypes; 4 topotypes; Nevada Test Site, Nye Co., Nev.

Miloderes mercuryensis Tanner.
Brigham Young Univ. Sci. Bull., Biol. Ser. 8(2):16. 1966.
2 paratypes; Nevada Test Site, Nye Co., Nev.

Crocidema arizonica Van Dyke.
Pan. Pac. Ent., 27:33. 1951.
1 paratype; Santa Catalina Mts., Arizona, 15 June 1933 (Owen Bryant).

Dyslobus alepidotus Ting.
So. Calif. Acad. Sci. Bull. 36:79. 1937.
2 paratypes, 2 topotypes; Sigmond Stern Grove, San Francisco, Calif.

Dyslobus washatchensis Tanner.
Proc. Utah Acad. Sci., Arts, and Letters, 15:147-148. Figs. 1, 2, 3. 1938.
Holotype, allotype, and 50 paratypes, Aspen Grove, Mt. Timpanogos, Utah Co., Utah, July 1936 (Vasco M. Tanner).

Omias albus Van Dyke.
Pan. Pac. Ent., 11:96, 1935.
2 paratypes; Lind, Washington, 3 June 1921 (M. C. Lane).

Cercopeus bolli Burke.
Southwestern Nat., 8:164-166, Fig. 5, 1963.
1 paratype; 10 miles southwest of Elkhard, Texas, 15 June, 1961 (H. R. Burke).

Nemocestes longulus Van Dyke.
Pan. Pac. Ent., 12:26, 1936.
1 paratype; Saticoy, Ventura Co., California, June 1924 (S. Flanders).

Nemocestes tuberculatus Van Dyke.
Pan. Pac. Ent. 12:28, 1936.
1 paratype; Muir Woods, Marin Co., California, 30 July 1908.

Nemocestes sordidus Van Dyke.
Pan. Pac. Ent., 12:36-27, 1936.
1 paratype; San Jose, California, 1 Aug. 1931.

Bagous lengi Tanner.
Great Basin Nat., 4:13, fig. 3, 1943.
Type; 3 paratypes; Iowa 207; 2 paratypes; Lake Okoboji, Iowa, 14 July 1917 (L. L. Buchanan).

Bagous longirostrus Tanner.
Great Basin Nat., 4:18, fig. 5, 1943.
1 paratype; Buffalo, New York; 1 paratype; Michigan.

Bagous texanus Tanner
Great Basin Nat.. 4:20, fig. 6, 1943.
4 paratypes; Victoria, Texas (J. D. Mitchell) (*Cyporus virens*).

Bagous maculatus Blatchley.
Rhynch. of N. E. America. Indianapolis, 1916.
1 paratype; Dunedin, Florida, 19 March 1917 (W. S. Blatchley), p. 232.

Bagous chandleri Tanner
Great Basin Nat. 4:26, fig. 8, 1943.
Type and 1 paratype; east side Utah Lake, Utah, 14 June 1941. 4,000' elevation (H. P. Chandler).
3 paratypes; Bear River, Utah.

Bagous sellatus LeConte.
Rhynch. of Amer., Proc. Am. Phil. Soc. SV, 1876.
1 homotype; St. Augustine, Florida, Liebeck Collection, Compared by F. G. Werner, 1942.

Bagous obliquus LeConte.
Rhynch. of Amer., Proc. Am. Phil. Soc. XV, 1876.
1 homotype; Enterprise, Florida, May 25, Museum Comparative Zoology. Compared by F. G. Werner, 1942.

Bagous americanus LeConte.
LeConte and Horn, Rhynch. 1876, p. 185.
1 homotype; N. J. Museum, Comparative Zoology. Compared by F. G. Werner. 1942.

Bagous cavifrons LeConte.
LeConte and Horn, Rhynch. 1876, p. 186.
1 homotype; Mass., Blatchley Collection. Compared by F. G. Werner.

Bagous magister LeConte.
Rhynch. of Amer., Proc. Am. Phil. Soc. XV, 1876.
1 homotype; Good Haven, Mich. (W. G. Dietz). Compared by F. G. Werner, 1942.

Bagous transversus LeConte.
Rhynch. of Amer. Proc. Am. Phil. Soc. XV. :188. 1876.
1 homotype; Penn Yan, N. Y., July 19, 1925 (Babry). Compared by F. G. Werner. 1942.

Bagous tingi Tanner
Great Basin Nat., 4:27, fig. 9, 1943.
Type. 1 paratype; Lake Pilarcitos, San Mateo, California. 27 Aug. 1929 (P. C. Ting, M. Cazier).

Bagous restrictus LeConte.
Rhynch. of Amer., Proc. Am. Phil. Soc. XV, 1876.
1 homotype. San Tomas, Brownsville, Texas, VII-29 from Schaeffer Collection. Compared by F. G. Werner, 1942.

Bagous californicus LeConte.
Rhynch. of Amer. Proc. Am. Phil. Soc. XV, :187, 1876.
1 homotype; Los Angeles Co., California. Compared by F. G. Werner, 1942.

Bagous puritanus Blatchley.
Rhyn. of N. E. America, Indianapolis, 1916.
1 homotype, Drac., Mass. Blatchley Collection. compared by F. G. Werner. 1942.

Bagous pusillus LeConte.
Rhynch. of Amer., Proc. Am. Phil. Soc. XV, 1876.
1 homotype. Mt. Lee, written with pen and ink, difficult to read. Compared by F. G. Werner, 1942.

Bagous floridanus Tanner.
Great Basin Nat., 4:30. 1943.
3 paratypes; 2 - Enterprise, Florida, Liebeck Collection.
1 - Ithaca, New York, 3 June 1925 (M. D. Leonard).

Bagous dietzi Tanner.
Great Basin Nat., 14:74, 1954.
Type; Cyprus Mills, Texas (Schaupp).
1 paratype: Texas, Frederick (Blandhard Collection).

Bagous angustus Tanner.
Great Basin Nat., 14:73, 1954.
Type; Newman Lake, Washington, 9 July 1927 (M. C. Lane).

Pnigodes tuberosus Tanner.
Great Basin Nat., 4:35-36, fig. 12, 1943.
Type; Iowa.

Pnigodes buchanani Tanner.
Great Basin Nat., 4:33-34, fig. 10, 1943.
5 paratypes; Wolfe Canyon, Texas, various dates.
1 paratype; Mexico, Texas, 17 May 1907.
1 paratype; Texas.

Tychius albidus Schaeffer.
Jour. N. Y. Ent. Soc. 16:219, 1908.
1 cotype; Death Valley, April 91 K on *Prosopis julifiora.*

Tychius suturalis Schaeffer.
Jour. N. Y. Ent. Soc., 16:218, 1908.
1 cotype; Nogales, Santa Cruz Co., Arizona (F. W. Nenenmacher).

Dinocleus bryanti Van Dyke.
Pan. Pac. Ent., 29:101, 1953.
1 paratype; Selngman, Arizona, 3 August 1936 (Bryant).

Lixus perstriatus Chittnenden.
Proc. U. S. Nat. Mus. 77(Art. 18):5.
2 paratypes; Cortez, Colorado, 19 June 1925.

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Trigonops planicollis Hllr.
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Wien Ent. Zeit XXIX, 1910, p. 187.
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2 paratypes; 1 ♀ Tubuai Island. August 20, 1934, S. W. Ridge. Mt. Taita, 1,100 feet, Austral Islands (D. Anderson), 1 Tubuai Island, August 21, 1934, Mt. Taita, 1,200 feet, Austral Islands (beating) (E. C. Zimmerman).

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STUDIES ON RAPTOR MORTALITY IN WESTERN UTAH[1]

David H. Ellis, Dwight G. Smith, and Joseph R. Murphy[2]

In past studies of predatory bird destruction. Hickey (1949) found that 102 of his banded juvenile marsh hawks were shot during their first year of life, while more recently Sprunt (1963) reported that 91 of the 118 Bald Eagles known to have been killed in 1962 had been shot. Although Spofford (1964) and others have called attention to the high raptor mortality caused by illegal predator control programs. and Imler and Kalmbach (1955) have reviewed Bald Eagle destruction in the years of the bounty laws. the extent of mortality caused by indiscriminate shooting is unknown.

In this study we attempted to locate all raptors killed during a two year period in Cedar Valley. Utah County. Utah. The study was centered on a 12.1 mile stretch of gravel road paralleled by single cross bar utility poles which were frequently utilized as perches by predatory birds in the valley. The study area was located within an intermontane valley comprising some 170 square miles. and averaging 4,900 feet in elevation; dominant plants were big sagebrush (*Artemesia tridentata*) and shadscale (*Atriplex confertifolia*). The land is used for dry farming and sheep range. and supports two small settlements. The valley is also a favorite rabbit hunting locality and receives large concentrations of hunters. particularly on winter weekends.

Procedure

The initial survey of the study road took place on 29 April 1967. and it was then subsequently surveyed at intervals of approximately one to three months, until the fall of 1968 when the pole line was dismantled. For sake of comparison, surveys were also made of the same pole line following its divergence from the study road. Many additional miles of roads and cliffs were also surveyed in an attempt to locate dead birds.

Results and Discussion

Thirty dead raptors were found on the initial road survey; this total included 14 Golden Eagles, 14 *Buteo* hawks, 1 Sparrow Hawk. and 1 Great Horned Owl. By the end of the study period, a total of 38 dead raptors had been found along this road and an additional ten in the remainder of Cedar Valley (see Table 1). Density of kills on the study road averaged 3.14 birds per mile, and included an extreme situation in which four dead Golden Eagles were found under two adjacent poles. Those birds suffering the heaviest mor-

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[1] This study was supported in part by a grant from the National Audubon Society. Gratitude is expressed to them, and also to the Department of Zoology and Entomology, Brigham Young University for transportation and facilities.

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Table 1
DEAD RAPTORS FOUND DURING STUDY PERIOD
CEDAR VALLEY, UTAH

Golden Eagle (*Aquila chrysaetos*)	26
Bald Eagle (*Haliaeetus leucocephalus*)	2
Rough-legged Hawk (*Buteo lagopus*)	8
Ferruginous Hawk (*Buteo regalis*)	1
Red-tailed Hawk (*Buteo jamaicensis*)	2
Swainson's Hawk (*Buteo swainsoni*)	1
*Buteo**	5
Cooper's Hawk (*Accipiter cooperii*)	1
Sparrow Hawk (*Falco sparverius*)	1
Great Horned Owl (*Bubo virginianus*)	1
Total	48

*Not identifiable to species owing to decomposition.

tality included the eagles (26 Golden Eagles and two Bald Eagles) and the *Buteos* (seventeen dead birds of four different species). During this same period only one dead raptor was found along the segment of the pole line not paralleled by the road.

The approximate times of death were estimated from the degree of decomposition at the time of discovery and the rate of decomposition observed in birds found shortly following death. Four time periods were assigned from the study road data. It was estimated that nineteen raptors, including ten *Buteos* and nine Golden Eagles, had been killed before the winter of 1966-67. During the winter and spring of 1966-67, fourteen raptors, including seven Golden Eagles and five *Buteos*, were killed. Two more Golden Eagles were killed during the summer of 1967, and an additional three during the winter of 1967-68. The heaviest mortality occurred in the fall and winter period, which also coincides with the periods of heaviest sport hunting. Two final road surveys were taken after the dismantling of the pole line in the fall of 1968, but no recently dead raptors were found.

Twenty-three of the dead eagles were suitable for age analysis. Fifteen were immature Golden Eagles, six were adult Golden Eagles, and two were adult Bald Eagles. Both Hickey (1949) and Craighead and Craighead (1956) similarly found that the highest raptor mortality occurs among the juveniles, and attribute this to the inexperience of these birds. We found that when driving along the study road we could approach to within fifteen meters of juvenile eagles perched on the pole, while the adult birds rarely displayed such tolerance of human presence.

At least two known hunting methods were used to destroy the birds. During the day some hunters were observed to drive back and forth along the road for the express purpose of obtaining suitable raptor targets, while at night spotlights were employed to locate roosting birds. Evidently the large numbers or raptors present on certain winter days attract considerable attention from the sportsmen. For example, on the morning of 21 December 1967 we found eighteen Rough-legged Hawks, five Golden Eagles, two Ravens, three Marsh Hawks and one Prairie Falcon perched on poles along this twelve-mile segment of road.

An important aspect of this study concerns the probable causes of death of these predators. Of the 48 dead birds from the study area, only two were found sufficiently close to the road to indicate the possibility of their having been killed by vehicles. Poisoning was also considered as a possible cause of death, since several 1080 bait stations were located in Cedar Valley. Data furnished by U. S. Fish and Wildlife Service personnel would tend to indicate that high tolerance levels of predatory birds for this poison might eliminate it as a factor; we feel that such evidence is inconclusive, however, since no actual analyses of carcasses for 1080 or pesticide residues were made. Such analyses should definitely be a part of future studies of raptor mortality, in our area as well as elsewhere. In most cases, there were clear indications that the birds had been deliberately shot. For example, a Ferruginous Hawk nested immediately next to the study road and was photographed 8 April 1967 (Weston and Ellis, 1968). On 19 April 1967 it was found dead with holes in the head and body, and its legs and tail had been removed. Bodies of the raptors were almost always found intact and seldom scattered by scavengers. These remains often exhibited shot holes in the feathers and bones. The preponderance of the evidence available appears to support the hypothesis that shooting was the cause of death for a majority of the raptors found.

In our opinion, this brief study highlights a major problem relating to the future survival of raptorial birds; it also demonstrates gross disregard of present federal and state laws protecting raptors on the part of a segment of the public. Additionally, it emphasizes the present danger of indiscriminate shooting to high concentrations of raptors, and the possible extent of such mortality in relatively small areas.

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Volume XXIX, No. 4
December 31, 1969

The Great Basin NATURALIST

PUBLISHED BY
BRIGHAM YOUNG UNIVERSITY

GREAT BASIN NATURALIST

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XXIX December 31, 1969 No. 4

QUALITATIVE BEHAVIOR OF A PUPFISH (*CYPRINODON ATRORUS*) IN DIFFERING ENVIRONMENTS

Murray Itzkowitz and W. L. Minckley[1]

Introduction

Fishes have been used extensively by ethologists, and there are many papers that have contributed greatly to the understanding not only of fish behavior, but of general ethological theory as well (Aronson, 1949; Baerends and Baerends-Van Roon, 1950; Baerends, *et al.* 1955; Morris, 1958; Barlow, 1961a, *et seq.*; Nelson, 1964; Liley, 1966; Simpson, 1968; Miller and Hall, 1968; many others). However, since certain behaviors are modifiable (Hess, 1962; Marler and Hamilton, 1966), it is surprising that there are so few studies that compare a fish's behavior in differing environments. The present report describes qualitative differences in behaviors elicited by a pupfish, *Cyprinodon atrorus* Miller, in aquaria and in natural and semi-natural habitats.

Materials and Methods

Cyprinodon atrorus inhabits saline marshes and lakes on the floor of the Cuatro Ciénegas basin, central Coahuila, northern México (Minckley and Itzkowitz, 1967; Miller, 1968; Minckley, 1969). Such habitats are severely variable, warming and cooling rapidly and subject to radical changes in salinities, dissolved oxygen, and so on (Minckley and Cole, 1968), and support only the most resistant biotic elements. *C. atrorus* is often the only fish species present at a locality, but another cyprinodontid, *Lucania interioris* Hubbs and Miller, and two poeciliids, *Gambusia longispinis* Minckley and *G. marshi* Minckley and Craddock, are sometimes abundant. Observations on the behavior of *C. atrorus* have been made at numerous places in nature, most intensively by Minckley and Elena T. Arnold in summer 1968. The activities observed were similar to those observed in a semi-natural pond (described below).

The pupfish used for study all originated from a stock caught in December 1963 from marshes associated with Laguna de San

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Pablo, 13 kilometers south-southeast of the village of Cuatro Ciénegas de Carranza, Coahuila, México. Seventeen individuals were placed in an artificial pool in March 1964, and by August a large, stabilized population had developed. It was studied intensively between 2 February and 30 April 1966. Breeding activities of this pupfish in nature begin in late January, intensify through early July, then decline to continue throughout the summer at a lower level. A second period of intense breeding activity often occurs in early autumn. The climate in Tempe, Arizona, is similar to that in the Cuatro Ciénegas area, and the fish also behave similarly. The semi-natural pond was isolated from disturbances in a large patio at Arizona State University. It was cement lined, but had a several-year accumulation of flocculent calcareous sediment. Considerable shade and organic input occurred from an overhanging mesquite (*Prosopis*), and city water continuously passed through the system. Maximum dimensions of the irregularly-shaped pool were 6 by 8 meters (m), and maximum depth was about 1.25 m (Fig. 1). Fishes were maintained without supplementary feeding. Observations were from a point about two meters above the water, by naked eye and through use of binoculars. Other vertebrates in the pond included poeciliid fishes, *Xiphophorus couchianus* (Girard) and *Flexipenis vittatus* (Hubbs), and a box turtle, *Terrapene coahuila* Schmidt and Owens. *Xiphophorus* were rare, *Flexipenis* built a large

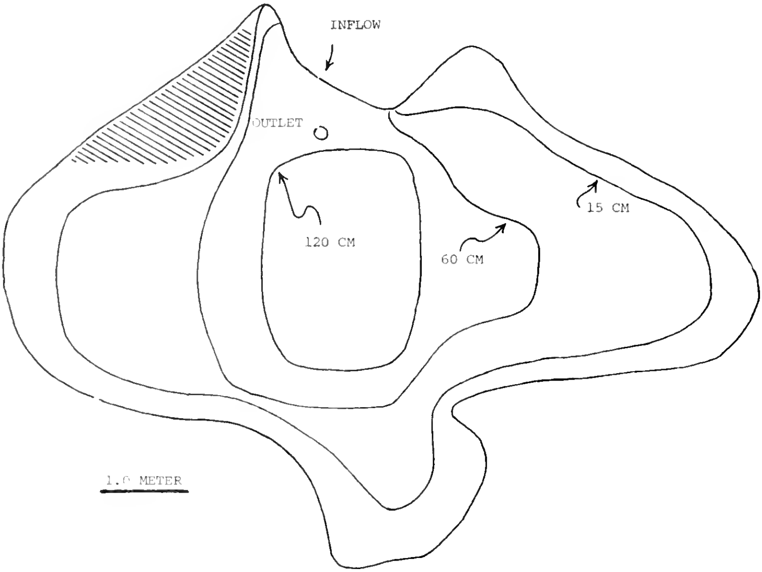

Fig. 1. Sketch map of the semi-natural pond at Tempe, Arizona, where *Cyprinodon atrorus* from the Cuatro Ciénegas basin, Coahuila, México, was studied. Contours are approximate, depths are in cm, and the hatched area is in the position of territories that were specifically observed.

population at the last of the study period, and the turtle was secretive during the day.

MOTOR PATTERNS

A behavioral sequence such as courtship consists of discrete motor elements (*e.g.*, muscle contractions) that occur with other such elements to produce synchronized patterns. Categorization is subjective since an observer must interpret the beginning and end of a given pattern, and evaluate variations. Major interpretive problems arise in description of numbers or intensities of components, or in the amount of time required for their completion. For present purposes, motor patterns making up broader behavioral sequences were weighted equally, and attempts were made to describe and evaluate variations. Where possible, names and definitions of patterns follow Barlow (1961a), as denoted by quotation marks.

Contacting.—"As the female moves slowly over the bottom the male stays beside her, and her head is usually just in front of his. Often they are actually touching."

Tilting.—The female swims slowly within 0.5 centimeters (cm) of the bottom and tilts her body downward at an angle of 30° to 45°. All unpaired fins are spread. Barlow (1961a) considered this the beginning of nipping (see next), but in *C. atrorus* nipping may be omitted following a tilt.

Nipping.—"From the tilted position, the female opens her mouth, presses against the bottom, and normally takes up a mouthful of the substrate. . . . Then the body is dropped down against the bottom. When horizontal, the female either immediately spits out the substrate, or swims forward a short distance, stops, and then expels it." We include "halting" as described by Barlow (1961a) as a terminal component of a nip.

Sidling.—"The male swims forward and laterally against the female. The male's dorsal fin is folded or half open. The region supporting the anal fin of the male is thrust against the posterior line of the abdomen of the female. The body of the male is tipped out of the median plane only slightly, or not at all."

S-shaping.—"Seen from above, the body of the pupfish forms a gentle 'S' . . . . At this time the male and female normally lie side by side on the bottom in parallel S-shapes. The curvature is more pronounced in the male. The head and anal region of the male are directed toward the female, and the anal fin of the male is extended in her direction. The dorsal fin of the male is spread, and sometimes is bent slightly toward the female. In the female the dorsal fin is spread maximally. Moreover, her vent is pressed against the bottom and her caudal fin beats rapidly, but with a very small amplitude."

Wrapping.—During S-shaping the male wraps his anal fin around the anal fin of the female.

Jerking.—"While still S-shaped the head is jerked toward the side opposite that to which it is already directed, thus initiating a wave of contraction which passes down the body reversing the direction of the S-shape. In the female one egg [or more] is extruded by this flexure, and the male presumably emits sperm at this moment."

Slow Rising.—Both the male and female slowly rise from the substrate after a wrap. The female then moves away at high speed, and this is almost invariably the termination of spawning by the pair.

Patrolling.—"The male in his territory swims straight ahead in spurts of about 30 to 50 cm with the dorsal, anal, and pectoral fins folded back . . . . At the end of each spurt the male stops abruptly by throwing the colorful pectoral fins forward together in a quick movement that catches the eye. Then the male stands momentarily with the median fins raised, and the pectoral fins beating alternatly and rapidly. . . . Then he swims off again in a new direction. In this manner the male pupfish continually crisscrosses his territory."

Chasing.—An aggressive fish swims at high speed, often with its mouth open, toward a fleeing individual. If opportunity arises an aggressor will bite or butt a fleeing fish.

Lateral Display.—A fish spreads all its fins and presents its flank to another fish. The two fish often simultaneously present a lateral display in a parallel position, with bodies held head high and at an angle of 20° to 45° to the substrate.

Tailbeat.—Through use of the caudal fin a fish appears to push water against the side of another fish. Usually a lateral display is the beginning movement of a tailbeat; a more complete description was given by Barlow (1961a).

Following.—This pattern appears to have three basic variations that depend on the depth and speed of movement of a female and is subdivided for convenience as follows: 1) below—a female swims at slow to moderate speed with all fins extended, 10 cm or more above the substrate, and the male is either directly 2.5 to 3.0 cm below, or at a similar depth below, but behind, with his dorsal and anal fins half extended to completely depressed; 2) above—similar to "following below" except that the male is above a female, usually when the female is less than 10 cm above the substrate; and 3) in line—similar to "following above and below" except that the male is directly behind a female at any depth, and the female usually is swimming faster than when the other two patterns are utilized.

Looping.—There are five definable variations of looping. In all instances a male swims in a circle, semi-circle, or "figure-eight." 1) Below—a female in mid-water or near-surface, and stationary, often has a male directly below and swimming in a circle with all fins extended; 2) in front—a female may be at any depth, but usually at least 7.5 cm above the substrate with unpaired fins spread, and the male makes a circular loop or figure-eight directly in front or slightly in front and below; 3) to the side—similar to "looping in front" except that a male is to the side of the female; 4) sidle—a male assumes a sidle position (described above) then leaves a female to loop in front, then returns (most often on the other side) to continue a spawning sequence; and 5) zig-zag—a female stationary or moving slowly, with fins spread, is approached from a distance of 10 to 30 cm by a male performing continuous semi-circles (a male may also swim away making such movements, and in such instances the female may follow the male). The looping pattern, with many variations, also is used by territorial males in display against intruders.

Nuzzling.—This describes a motor pattern in which a male touches a stationary female with the anterior part of his body. 1) one—A male is below a stationary female and moves upward until the head and nape come into contact with, or slightly posterior to her branchiostegal region, then moves slowly back to the anal fin, around the side, and forward to a typical contact; 2) two—similar to "nuzzling one" except that a male moves directly to contact position without moving back to the anal fin; and 3) top—a male touches his lower head and breast to the dorsum of a female's head, then moves laterally and down to contact.

Courtship and Spawning in the Artificial Pond and in Nature

The male of *Cyprinodon atrorus* is a highly aggressive, vigorously territorial animal. The bright, irridescent blue body and contrasting yellow-orange fins, plus bold patrolling within a limited area, must make him conspicuous to other fish, and these features may also serve as a display to attract females that are willing to spawn. A female, when prepared to spawn, moves into a male's territory and nips the substrate. If the male is inattentive, the female may nip several times, until the male approaches. Upon sighting a female, the motor patterns given above were scarcely evident in nature or in the semi-natural pond. The male swam directly toward the female at high speed, as if she were an intruder, or sometimes used a zigzag loop in his approach. Moreover, most males immediately assumed a contact position, with no intermediary display. This was followed by a tilt and nip or a lunging nip by the female. The male sidled, both S-shaped, he wrapped, and both fish slowly rose. The female then swam from the territory at high speed, with the male following behind (a pursuit indistinguishable in such instances from a charge used when chasing an intruder). In totals of 116 observed spawns in the pond and 50 in nature that ended in a slow rise, this repertoire was invariable in sequence (Fig. 2).

One unusual series of observations were made of a pair "trapped" in a small area by surrounding clumps of filamentous algae. The male was exceedingly active, looping in front almost continuously then quickly contacting after the female nipped. The water was less than 1.5 cm deep, so a slow rise rarely followed a spawn. Both lay quietly for a second or so, then the female would dart forward with the male following in line. Algal mats blocked the female's rush, and she stopped after 3 to 5 cm. The male immediately began nuzzling and attempting to contact. This resulted in a nip and another spawn 12 of 33 times in a 31-minute period. The other times the female fled and dove into algae, followed by an active, looping search by the male. The female would re-appear, fanning her extended fins "nervously," and would nip or remain stationary. In the latter case she was immediately nuzzled and contacted, and nipped

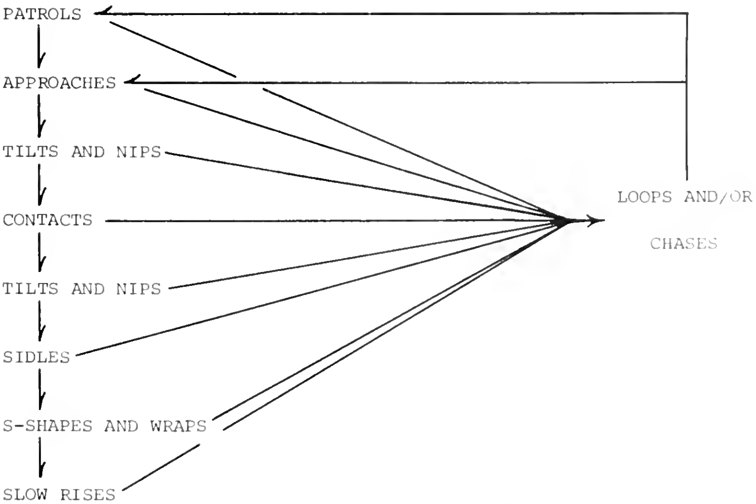

Fig. 2. Courtship and spawning sequences of *Cyprinodon atrorus* in natural and semi-natural habitats.

and spawned or again fled to hide. No other observations of nuzzling have been made under field conditions, and no such hyperactivity has otherwise been noted in *C. atrorus* under natural or semi-natural conditions.

In any stage of a reproductive sequence a male would leave a female to challenge an intruder. In the pond between February and late April about 50 percent of the females that nipped the substrate in a male's territory failed to spawn, and most times this resulted from interruption by other fishes. No quantitative data are available from observations in nature, but disturbances of a similar nature were often seen. While some discrimination by a non-spawning male between homo- and heterospecific interlopers was evident, no such recognition was obvious when a male was interrupted during a spawning sequence. Even intruding poeciliids were aggressively driven from the area when a defender was spawning, as were young *C. atrorus* that are oftentimes ignored by defending males. Since looping also occurred when no interlopers were present, or when a male was returning to a female after chasing, it may also serve to pacify a "nervous" female or to block her retreat from the spawning area.

The motor patterns of tilting, jerking, following above, and following below were not observed in the pond or in nature.

Courtship and Spawning in Aquaria

Male and female *Cyprinodon atrorus* were first kept isolated for a number of days in separate, 28-liter tanks (35 by 26 by 22 cm), then a male was introduced into a female's tank. Upon introduction, a male always initially sank to the bottom, or moved into a position along a wall. The female also would sink to the substate, with all fins extended. The female initiated activity, swimming to the male and tilting and/or nipping the substrate nearby. If a male was inattentive a female would "mildly" butt or bite at his body. Males sometimes responded to such aggression with tailbeat, and if this occurred the female always retreated. When a nip occurred the male usually swam directly to a contact position. Typical behavior consisted of a variable period of contact, followed by a sequentially-inconsistent assemblage of motor patterns on the part of the male that eventually terminated in a spawn (Fig. 3). On the average, in 668 observed spawns, a sequence of contact→ tilt and/or nip→ S-shape→ wrap→ jerk or slow rise predominated (Fig. 4).

Females under conditions of aquarium isolation often remained receptive to a male after the initial spawn. Females with high sexual tendencies spawned immediately after the pair was placed together, then began swimming slowly through the tank, conveniently accessible to the male. This is not the case in nature since a female immediately leaves the male's territory after the spawn is consummated. The presence and "receptivity" of a female stimulated hyperactive sexual behavior on the part of a male, such as nuzzling, looping, and following. These displays had little if any sequential cor-

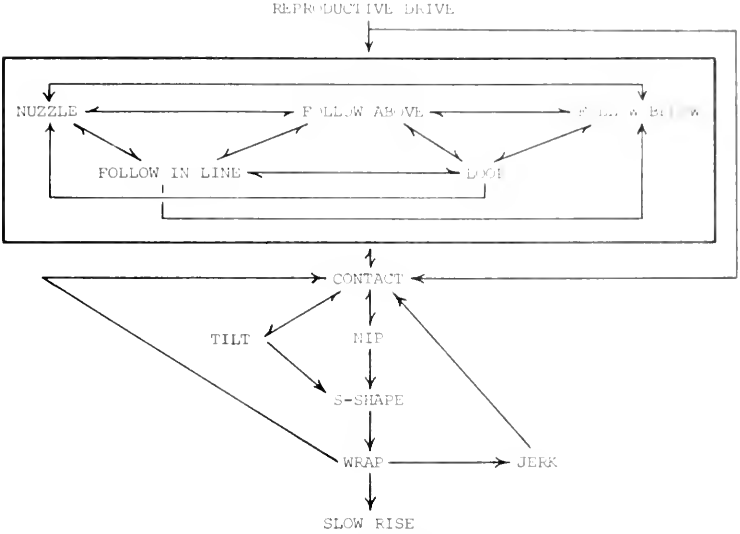

Fig. 3. Relationships of courtship and spawning motors patterns of *Cyprinodon atrorus* in laboratory aquaria.

relation to one another or to other patterns (contacting, nipping, *etc.*) of a more terminal spawning sequence. However, 41 percent of the courtship patterns (whatever they were) led directly to a second spawn. The behavior, notwithstanding its variations, must therefore have succeeded in stimulating the female to continue reproductive activities. When a female was not initially prepared to spawn, a similar series of random patterns was produced by a male. However, it was rare for a male to induce an initially unresponsive female to spawn.

The male *C. atrorus*, when territorial, is always receptive to a female, and the female controls spawning by presenting herself within a territory and performing the niping pattern. The female apparently requires little stimulation by a male (excepting, perhaps, a short period of contacting, or some visual stimulation from male defensive activities) when she is prepared to spawn. Random use of courtship motor patterns appears to function in stimulation of a female to continue the spawning activities, rather than as an initiator. Rigid courtship sequences require reciprocal stimulation, and randomness of behavior of male *C. atrorus* may result from a lack of cues from the female.

TERRITORIALITY IN THE SEMI-NATURAL POND AND IN NATURE

Males of *Cyprinodon atrorus* begin to establish territories in late January, and remain aggressive throughout the breeding season with the intensity of behavior varying with intensities of reproductive activities in the given habitat. Males began sporadic aggressive ac

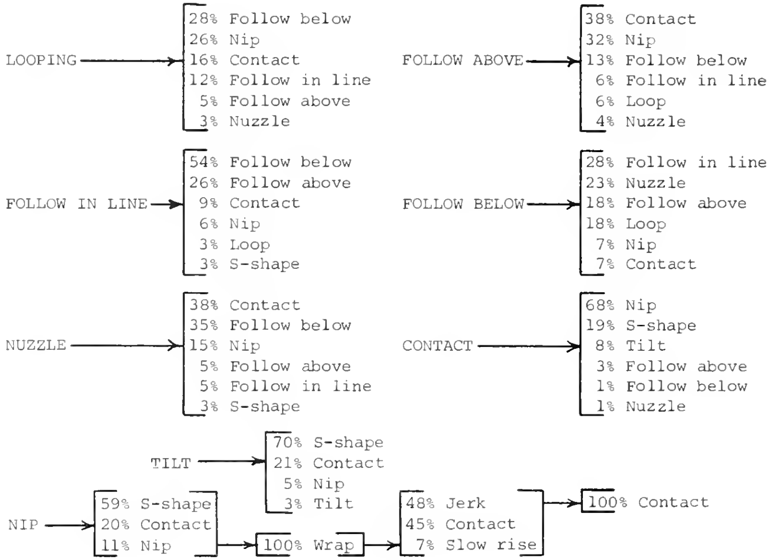

Fig. 4. Quantitative relations among a motor pattern and those patterns observed to follow it in *Cyprinodon atrorus* under laboratory aquarium conditions, based on 668 observed spawnings.

tions in February in the artificial pond. Fights were not confined to a particular area, and usually consisted of short charges with little or no contacting. Some fighting was associated with feeding pits during this period, an activity continued almost throughout the year by nonreproductive males, females, and juveniles (Minckley and Arnold, 1969). Pit-building and defense is unrelated to reproductive activities in *C. atrorus*, although it may have significance in the sexual behaviors of some other pupfish species (E. T. Arnold, pers. comm.).

In mid-February, several males established temporary areas in shallows of the semi-natural pond, but these were not defended for more than a few hours. They were 15 to 25 cm in diameter in water not more than 5 cm deep. Boundaries were ill-defined and frequently changed more than five cm in a few minutes. Border fights between neighboring fish rarely occurred since territories were widely dispersed and usually isolated. Permanent territories were formed by late mid-February, and three, well-defined, adjacent ones were selected for intensive observations. These were situated in a cove that sloped gently to a maximum depth of eight cm. On the pondward side was an abrupt slope leading to water more than 30 cm deep. The territories were at depths between 2 and 8 cm (Fig. 1), and occupied all available shallow water. The largest included about 2,100 square centimeters (cm^2) and the smallest was 1,050 cm^2 in size. The range in estimated sizes for territories in nature is 3,200 to 875 cm^2 (23 estimates), with a mean of about 1,950 cm^2. Shapes of territories ranged from round in open, sparsely populated areas, to elongate and highly variable where heterogeneity of habitat, or the presence of other males, influenced the boundaries. The three males in the pond vigorously defended their respective areas until mid-March. Others then began to form peripheral territories, and wedges defended by new males were progressively forced into and between the three original ones. The three defended areas were markedly compressed to about half their original sizes, and within a week the fish had been displaced and disappeared.

Territorial defense by *C. atrorus* consists of numerous lateral displays, infrequent tailbeats against peripheral males, and charges against non-territorial males and sometimes females and juveniles. Actual contacts and severe fighting occur when territorial boundaries of "matched" males (in size and coloration) are closely appressed, especially when the border meets in relatively deep water (>5 cm). Under such conditions the males present sustained lateral display, tailbeat, and biting, the last generally in the vicinity of the anal fin and flanks. Contact fighting, although rare, usually begins near the surface, and the two males spin about each other as they gradually move toward the bottom. Fights are sustained for as long as 30 seconds, and a small cloud of sediment often obscures the terminal phases of such conflict. Tinbergen (1953), Carranza and Winn (1954), and Miller (1964) have noted that the ferocity of attack by a defending male of fishes they studied (*Gasterosteus aculeatus* Linnaeus, *Fundulus notatus* [Rafinesque], and *Trichogaster trichopterus* [Pallas], respectively) increased as the interloper more closely approached the territorial mid-point. However, this type of differential aggression did not obviously occur in *C. atrorus*. The defending male appeared to attack all intruders (excepting young and reproductively-oriented females) with equal aggressiveness, regardless of their distance from the center of this area.

TERRITORIALITY IN AQUARIA

Results from a number of experiments with *Cyprinodon atrorus* in aquaria are similar, and only one is described here. A bare, sand-bottomed, 160-liter tank was used to attempt to duplicate the territorial sequences observed under field conditions. Seven adults of generally equal size, 3 males and 4 females, were placed in the tank, and they immediately formed a tightly-knit, stationary cluster (a "pyramid") near the substrate. They remained in that position for several minutes, then began exploratory swimming. When disturbed they immediately returned to a pyramid cluster. By the second day the fish began to seek individual refuge when disturbed. There was sporadic aggression, not limited to any particular area. On the third day one male defended a small area near the substrate for a short time. At the end of the first week, one male rigorously defended the entire bottom of the tank, from the substrate to about eight cm above, making frequent forays against fish positioned at higher levels. When attacked, other fish fled without defensive display. At the end of the second week another male began to defend a 10- by 38-cm area at one end of the tank, positioned about 8 cm above the bottom and extending to the surface. This was defended against all but the male who continued to patrol the substrate. The third male did not establish an area, and was intimidated by both other males. There was continual, mild, aggressive activity among the females, and they often attacked the subservient male. None of the female attacks was prolonged, but consisted merely of a short charge terminating in a butt or bite. The hierarchy in males was maintained for a month, when the experiment was terminated. These results are similar to those obtained by Barlow (1961a) for *Cyprinodon macularius* Baird and Girard, and have bee nduplicated in our laboratory using a number of other pupfishes.

Discussion and Conclusions

The study of behavior of fishes in the wild is exceedingly difficult, and the abundance of variables existing under field conditions makes it simple to overlook significant factors and to arrive at spurious conclusions. In the laboratory, new factors are introduced by creation of "standard conditions," and data acquired from fish in aquaria may be equally misleading.

Behavior of *Cyprinodon atrorus* in natural and semi-natural habitats lacked many components that were commonly present under aquarium conditions. Nuzzling, for example, generally occurred only when a stationary female was 10 or more cm above the substrate, and when she remained for some period of time in a male's territory. Since all territories in nature or in the pond were in water shallower than eight cm (and usually less than five cm), physical limitations precluded performance of the pattern. The absence of following (especially above and below) under field conditions may also be attributable to insufficient depths. In addition, females in the pond did not remain in the territory after a spawn, but moved away at high speed so that little time was allowed for the male to perform complex display patterns (with the notable exception discussed on page 00).

The lack of records of the jerk motor pattern in nature and in the pond is confusing. Barlow (1961a) implied that this was correlated with passage of gametes; since young were abundantly produced in the semi-natural pond, a jerk is obviously not essential for successful reproduction. The jerk motor pattern in aquaria always led to a continuance of spawning (Fig. 3), and only a slow rise resulted in its termination. However, on the one occasion when repeated spawning by a pair of fish was observed under field conditions (p. 00), the female did not jerk, and repeatedly utilized a slow rise (or a period of quiescence in shallow water) after spawning.

Tilting is difficult to observe from above, and may be physically impossible for a female in shallow water, and these factors may explain its almost-complete absence from the behavioral repertoire in the pond. Highly motivated females in aquaria always tilted, but often omitted a nip in their pre-spawning movements.

The abbreviated, "to-the-point" spawning sequence under natural conditions, highly stereotyped and almost invariable, may be a result of the over-riding territorially of the male *C. atrorus*. A male will curtail spawning at any point to chase an intruder in his territory. When a pair is placed in a habitat devoid of other fishes the barraging effect of stimuli from interlopers is removed and the pair may receive and react to other facets of their immediate surroundings. Sexuality becomes the only broad stimulus, and subtleties of activities on the part of each fish create a diversity of reactions in each. Variability in their behavioral repertoires, such as occurs in aquaria with the appearance of several courtship patterns, may then ensue. This is supported somewhat by the diverse behavior exhibited by the pair of fish isolated under semi-natural conditions by algal mats (p. 00).

Development of territorial behavior in the laboratory is very similar to that occurring under field conditions. Sporadic fighting precedes acquisition of temporary territories, and fixed territories remain relatively permanent. The artificial confinement in a tank allows (or forces) development of a hierarchy. If these occur in nature they are highly complex and localized. Males unable to hold or establish territories in nature remain in deep water and avoid contact with aggressive individuals, and smaller males sometimes defend stones or vertical banks in peripheral areas. These kinds of behavior correspond generally to the activities of the non-dominant males in aquarium situations.

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DOES *VIREO GILVUS SWAINSONII* OCCUR IN UTAH?

Gary L. Worthen[1]

While attempting to subspecifically identify a series of forty-two Warbling Vireos collected in south central, western Utah for a recent work (Worthen, 1968), a problem of subspecific distribution became apparent. Twomey (1942), Woodbury and Russell (1945), Behle (1948), Woodbury, Cottam, and Sugden, (1949), Behle (1955), A.O.U. Check-list Committee (1957), Behle, (1958), and Behle (1960), state that *Vireo gilvus swainsonii* Baird occurs or may occur in Utah. Most of these authors designate the subspecies as a migrant but some record it as a summer resident in certain localized areas of the state.

I examined a series of 200 birds in the collection of the University of Utah and can find little evidence that *V.g. swainsonii* occurs in Utah. It should be pointed out, however, that I have not examined any topotypes or any specimens positively identified as *V. g. swainsonii*. Characteristics were used that were given by the original describer (Oberholser, 1932) and by Sibley (1940).

Virtually all specimens in the University of Utah Museum that have been identified as *V. g. swainsonii* are birds taken in August and September in fresh fall plumage. Furthermore, six of the seven birds taken by myself in August (Worthen, 1968) have characteristics of *V. g. swainsonii*. There is a decided paucity of birds taken in spring in the collection of the University of Utah referable to "*swainsonii*". These data present two possible hypotheses: that this subspecies commonly migrates south through Utah but usually migrates north by some other route, or that the observed relationship is caused by something other than patterns of migration. If the latter is true the factors which seem to be responsible are those dealing with molt and wear of plumage. Bent (1950:366) states that,

> There is a partial postjuvenal molt, beginning early in August, which involves the contour plumage, and the wing coverts, but not the rest of the wings nor the tail. This produces a first winter plumage which is practically indistinguishable from the winter plumage of the adult, greener above and more buffy white below than the previous plumage.
>
> Dr. Dwight says that the nuptial plumage is acquired by wear, but Ned Dearborn (1907) found March and April specimens of the western race undergoing a scattered molt on the head and breast.

It seems apparent that the fresh fall plumage of the resident subspecies (*V. g. leucopolius* (Oberholser)) would more closely approximate the characteristics of *V. g. swainsonii* than breeding birds of

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V. g. leucopolius in worn and faded plumage. It is, therefore, my contention that most (if not all) of the "*swainsonii*" in the collection of University of Utah are misidentified through confusion of variation in seasonal plumage with subspecific variation and are, in actuality, birds assignable to *V. g. leucopolius* in fresh fall plumage.

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LIST OF INSECT TYPE SPECIMENS IN THE ENTOMOLOGICAL COLLECTION OF THE BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH, NO. IV.

Vasco M. Tanner[1] and Don R. Harris[2]

There is a tendency at present in the biological sciences to shy away from systematics in favor of molecular biological studies. The Linnaean system of dealing with the multitudinous forms of animate nature is being seriously questioned. Today, biologists are concerned with the synthesis of the living environment at levels of organization such as the "biota, community, population, organism, cell, and molecule."[3] No doubt emphasis in this line of endeavor will prove to be revealing as to the similarity and unity of organisms. As advancements are made in this new approach to understanding the basic makeup of organisms, their similarity and life processes, there will still be a need for recognizing the great diversity of life forms. The causes that bring about diversity of organisms may be more clearly known and manipulated, but the end product, the objective entity, that which we now know as the species, will still exist.

Modern methods employed in taxonomy are superior to those of the Linnaean period and should, through additional refinements, continue to be one way of categorizing and reporting on the product of evolution. In systematizing plants and animals, workers have described the diverse forms and preserved, for future studies, some of the specimens used in the description of the new species. These specimens have been variously designated as: type, holotype, allotype, cotype, paratype, topotype and other designations. Experience has justified the preservation of specimens so designated by the author in making a description. Without the object described, it is well nigh impossible for biologists and research workers to make a satisfactory determination of some species. It is, therefore, in the interest of future research work with the insect group, that the species representing types are listed in these reports.

Entomology is an important discipline since it is concerned with the study of a large segment of animal life. Research in this field in the western states may be aided by having authoritative collections and some type material available at a focal point such as at this university.

ORDER ORTHOPTERA

FAMILY GRYLLACRIDIDAE

Ceuthophilus nevadansis Barnum.
Brigham Young Univ. Sci. Bul., Biol. Ser., 4(3):96-100. 1964.

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[3] Raven, P. H., and H. W. Richard. 1967. Syst. Zool. 16:1

Paratypes, 19 ♂♂, 16 ♀♀; Nevada Test Site, Nye Co., Nev. (Andrew Barnum).

Ceuthophilus deserticola Barnum.
Brigham Young Univ. Sci. Bul., Biol. Ser., 4(3)100-103, 1964.
Paratypes, 7 ♂♂, 9 ♀♀; Nevada Test Site, Nye Co., Nev. (Andrew Barnum).

ORDER HEMIPTERA

FAMILY MIRIDAE

Chlamydatus becki Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):28, 1968.
Paratypes, 2 ♂♂, 2 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino).

Microphylellus symphoricarpi Knight.
Brigham Young Uni. Sci. Bul., Biol. Ser., 9(3):30, 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight)

Plagiognathus salviae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):30, 1968.
Paratypes, 4 ♂♂, 4 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight and J. M. Merino).

Merinocapsus ephedrae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):34, 1968.
Partypes, 3 ♂♂, 5 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight).

Beckocoris laticephalus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):36, 1968.
Paratypes, 5 ♂♂, 5 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight, J. M. Merino).

Europiella punctipes Knight.
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Paratypes, 2 ♂♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight, D E. Beck).

Europiella lycii Knight.
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Paratypes, 1 ♂, 3 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight).

Europiella grayiae Knight.
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Paratypes, 5 ♂♂, 5 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight and J. M. Merino).

Europiella stitti Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):46, 1968.
Paratype, 1 ♀; Gila Bend, Ariz.; 13 Feb. 1941 (Loyd L. Stitt).

Europiella nigrofemorata Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9((3):39, 1968.

Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight. D E. Beck and J. M. Merino).

Europiella arizonae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):46. 1968.
Paratype, 1 ♀; Aztec, Ariz., 3 Feb. 1941 (Loyd L. Stitt).

Europiella nigricornis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):40. 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight, D E. Beck).

Europiella nicholi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):42, 1968.
Paratype, 1 ♀; Rincon Mts., Ariz., 2 Sept. 1923, Alt. 3,300 (A. A. Nichol).

Europiella albipubescens Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):46, 1968.
Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight. D E. Beck and J. M. Merino).

Europiella yampae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):43, 1968.
Paratype, 1 ♂; Steamboat Sprs., Colo., 12 July 1964, 6700′ (H. H. Knight).
1 ♀, Steamboat Sprs., Colo., 11 July 1964, 6700' (H. H. Knight).

Europiella unipuncta Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):44, 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (J. M. Merino, H. H. Knight).

Europiella rubricornis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):39, 1968.
Paratype, 1 ♂; Richfield, Utah, 11 June 1930, (Light Trap); (E. W. Davis).

Europiella rufiventris Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):42, 1968.
Paratypes, 1 ♂, 1 ♀; Goldwater, Arizona, 6 April 1940 (Loyd L. Stitt).

Psallus purshiae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):48, 1968.
Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight, J. M. Merino).

Psallus atriplicis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):48, 1968.
Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Phymatopsallus prosopidis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):49, 1968.
Paratypes, 4 ♂ ♂, 4 ♀ ♀; Nevada Test Site, Nye Co., Nev (D E. Beck, H. H. Knight).

Phymatopsallus rubesi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):50, 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (J. M. Merino).

Lepidopsallus arizonae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):52, 1968.
Paratypes, 1 ♂, 1 ♀; Mt. Lemon, Ariz., Santa Cat. Mts., 27 July 1917, 9000' (H. H. Knight).

Lepidopsallus nicholi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):52, 1968.
Paratype, 1 ♀; Empire Mts., 5000′, Ariz., 20 May 1928 (A. A. Nichol).

Lepidopsallus pini Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):53, 1968.
Paratype, 1 ♀; Ft. Garland, Colo., 10 Aug. 1925 (H. H. Knight) (*Pinus edulis*).

Lepidopsallus longirostris Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):54, 1968.
Paratypes, 1 ♂, 1 ♀; Pingree Pk., Colo., 20 Aug. 1925 (H. H. Knight).

Lepidopsallus monticola Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):54, 1968.
Paratypes, 1 ♂, 1 ♀; Veta Pass, Colo., 9 Aug. 1925 (H. H. Knight) (On *Pinus*).

Nevadocoris becki Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):59, 1968.
Paratypes, 3 ♂♂, 3 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight, D E. Beck and J. M. Merino) (*On Tetradymia*).

Nevadocoris pallidus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):60, 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight) (*On Grayia spinosa*).

Nevadocoris bullatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):60, 1968.
Paratypes, 2 ♂♂, 2 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight) (*On Chrysothamnus*).

Brachyceratocoris nevadensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):61, 1868.
Paratypes, 2 ♂♂, 2 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Macrotylus salviae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):62, 1968.
Paratypes, 2 ♂♂, 2 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck and H. H. Knght).

Coquillettia luteiclava Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):63, 1968.

Paratypes, 1 ♂; 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino).

Coquillettia albella Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):62, 1968.
Paratypes, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino). On *Eriogonum inflatum.*

Dicyphus ribesi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):70, 1968.
Paratypes, 2 ♂ ♂, 2 ♀ ♀; Nevada Test Site, Nye Co., Nev. (Beck, Marino and Knight).

Dicyphus hesperus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):73, 1968.
Paratypes, 1 ♂; Moscow, Idaho, 18 Mar. 1934; 2560′. (H. Shipman) (Mullen). 1 ♀, Genese, Ida., 23 May 1936 (R. E. Miller).

Dicyphus stitti Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):74, 1968.
Paratype, 1 ♂; Gila Bend, Ariz., 6 Oct. 1940 (Loyd L. Stitt). On *Martynia parviflora.*

Macrolophus mimuli Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):75, 1968.
Paratypes, 1 ♂, 1 ♀; Huachuca Mts., 6000′, Ariz., 14 June 1928 (A. A. Nicol). Breeding on *Mimulus cardinalis.*

Sixeonotus bebbiae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):76, 1968.
Paratype, 1 ♂; Mohawk, Ariz., 23 Apr. 1940 (Loyd L. Stitt).

Sixeonotus dextratus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):76, 1968.
Paratype, 1 ♂; Tucson, Ariz., Sabino Canyon, 23 July 1917 (H. H. Knight).

Sixeonotus areolatus Knight.
Bul. Brook. Ent. Soc. 23:243.
Paratype, 1 ♂; Rock Island, Tex., 3½ m. Northwest; 20 June 1922 (Grace O. Wiley).

Largidea nevadensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):84, 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino). On *Pinus monophylla.*

Labops hirtus Knight.
Brigham Young Univ. Sci. Bul., Biol.Ser., 9(3):88, 1968.
Paratype, 1 ♂; Yellowstone Park, Wyo., 20 July 1925 (A. A. Nichol).

Slaterocoris longipennis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):90, 1968.
Paratypes, 2 ♂ ♂, 2 ♀ ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Slaterocoris rubrofemoratus Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):90, 1968.

Paratypes, 1 ♂, 2 ♀♀; Nevada Test Site. Nye Co., Nev. (H. H. Knight). On *Artemisia tridentata.*

Lopidea deserta Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):99. 1968.

Paratypes, 5♂♂. 5 ♀♀; Nevada Test Site, Nye Co., Nev. (Beck, Knight and Merino).

Lopidea calli Knight.

Bul. Brook. Ent. Soc., 29:11. 1934.

Paratype. LaSal. San Juan. Co., Utah. June, 1927 (Anson Call, Jr.).

Lopidea becki Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):98, 1968.

Paratype. 1 fl; Nevada Test Site. Nye Co., Nev. (Beck, Knight. and Merino). On *Eriogonum umbellatum.*

Ceratopidea daleae Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):100. 1968.

Paratypes. 3 ♂♂. 3 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight). On *Dalea polyadenia.*

Daleapidea daleae Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):101, 1968.

Paratypes, 1 ♂. 1 ♀; Nevada Test Site, Nye Co., Nev. (Beck. Knight and Merino).

Hesperocapus plagiatus Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):103. 1968.

Paratype. 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Hesperocapus artemisicola Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):102. 1968.

Paratype, 1 ♂; Hudson. Colo., 25 Aug. 1925 (H. H. Knight) (*Artem. filifolia*).

Dichaetocoris nevadensis Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):103, 1968.

Paratypes. 2 ♂♂. 2 ♀♀; Nevada Test Site, Nye Co., Nev. (Knight and Merino).

Dichaetocoris merinoi Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):111, 1968.

Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (Knight and Merino). On *Pinus monophylla.*

Dichaetocoris pinicola Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):110. 1968.

Paratypes, 3 ♂♂, 3 ♀♀; Nevada Test Site, Nye Co., Nev. (Knight and Merino). On *Pinus monophylla.*

Dichaetocoris symphoricarpi Knight.

Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):112. 1968.

Paratypes, 5 ♂♂. 5 ♀♀; Nevada Test Site. Nye Co., Nev.

(Beck, Knight and Merino). Host plant *Symphoricarpos longifloris.*

Dichaetocoris juniperi Knight.
Brigham Young Univ., Sci. Bul., Biol. Ser., 9(3):113. 1968.
Paratypes. 3 ♂♂, 3 ♀♀; Nevada Test Site, Nye Co., Nev. (Knight and Merino). On *Juniperus ostrosperma.*

Dichaetocoris utahensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):114. 1968.
Paratype, 1 ♀; Scipio, Utah, 29 June 1965 (H. H. Knight).

Dichaetocoris stanleyaea Knight.
Brigham Young Univ. Sci. Bul., Biol Ser., 9(3):115, 1968.
Paratypes, 2 ♂♂; Nevada Test Site, Nye Co., Nev. (Beck, Knight and Merino). Host plant *Stanleya pinnata.*

Dichaetocoris coloradensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):116. 1968.
Paratypes. 1 ♂, 1 ♀; Durango, Colo., 13 Aug. 1925 (H. H. Knight).

Melanotichus shoshonea Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):125. 1968.
Paratypes, 1 ♂; Yellowstone Nat. Park, Wyo., 8 Aug. 1937 (H. H. Knight). 1 ?, Shoshone Nat. Forest, Wyo., 7 Aug. 1927 (H. H. Knight).

Melanotrichus azteci Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):122. 1968.
Paratype. 1 ♀; Phoenix, Ariz., 17 Mar. 1939 (Loyd L. Stitt).

Melanotrichus malvastri Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):120. 1968.
Paratypes, 1 ♂, 1 ♀; Whittier, Cal., 18 April 1935 (E. L. Paddock).

Melanotrichus nevadensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):122, 1968.
Paratypes, 5♂♂, 5 ♀♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino). On *Artemisia tridentata.*

Melanotrichus pallens Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):125. 1968.
Paratypes, 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight and J. M. Merino).

Melanotrichus eurotiae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):128. 1968.
Paratypes, 5 ♂♂, 5 ♀♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight and J. M. Merino). Taken on *Euratia lanata.*

Melanotrichus atriplicis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):125. 1968.
Paratype, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino). Taken on *Atriplex canescens.*

Parthenicus furcatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):133, 1968.
Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (D E. Beck and J. M. Merino). Taken at incandescent light.

Parthenicus pinicola Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):140, 1968.
Paratypes. 1 ♀; Grand Canyon, Ariz., 40 mi. South, 3 Aug. 1917 (H. H. Knight). 1 ♂; Durango, Colo., 13 Aug. 1925 (H. H. Knight).

Parthenicus merinoi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):135. 1968.
Paratype. 1 ♂; Nevada Test Site, Nye Co., Nev. (D E. Beck and J. M. Merino).

Parthenicus atriplicis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):135, 1968.
Paratypes, 1 ♂. 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino).

Parthenicus incurvus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):150. 1968.
Paratype. 1 ♂; Nevada Test Site. Nye Co., Nev. (D E. Beck and J. M. Merino).

Parthenicus becki Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):149. 1968.
Paratypes. 1 ♂. 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Parthenicus conspersus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):139, 1968.
Paratypes. 1 ♂. 1 ♀; Richfield. Utah, 8 July 1930 (Light trap). (E. W. Davis).

Parthenicus cowaniae Knight.fl
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):148, 1968.
Paratypes. 1 ♂. 1 ♀; Grand Canyon. Ariz., 3 Aug. 1917 (H. H. Knight).

Parthenicus boutalouae Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):154. 1968.
Paratype. 1 ♀; Hauchuca Mts., 6000′. Ariz., 14 June 1928 (A. A. Nichol). On *Bouteloua gracilis.*

Ceratocapsus nevadensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):156. 1968.
Paratypes. 2 ♀; Nevada Test Site. Nye Co., Nev. (D E. Beck. H. H. Knight and J. M. Merino). Taken on *Sphaeralcea.*

Pilophorus miscosetosus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):169. 1968.
Paratypes, 1 ♂. 1 ♀; Nevada Test Site. Nye Co., Nev. (H. H. Knight and J. M. Merino).

Pilophorus merinoi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):175, 1968.

Paratypes, 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. M. Merino).

Pilophorus utahensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):175. 1968.
Paratypes, 1 ♂; Gnd. Junc. Colo., 28 July 1900; 1 ♀: Leeds, Utah, 12 Oct. 1952 (E. W. Davis).

Pilophorus nevadensis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):172. 1968.
Paratype, 1 ♂; Wells, 15 mi. East, Nev. 12 July, 1965 (H. H. Knight).

Pilophorus hesperus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):169. 1968.
Paratypes, 1 ♂, 1 ♀; Estes Park, Colo., 24 Aug. 1925 (H. H. Knight).

Pilophorus diffusus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):168. 1968.
1 Paratype: Pingree Park, Colo., 20 Aug. 1923 (C. J. Drake).

Pilophorus dislocatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):171. 1968.
Paratype, 1 ♀; Huachuca Mts., Ariz., 29 July 1905 (L. L. Stitt).

Pilophorus salicis Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):173. 1968.
Paratypes, 1 ♂; Las Animas, Colo., 6 Aug. 1925 (H. H. Knight). 1 ♀, Wray, Colo., 4 Aug. 1925 (H. H. Knight).

Irbisia shulli Knight.
Bul. Brook. Ent. Soc., 36:75. 1941.
Paratypes, 1 ♂; Lenore, Ida., 7 May 1938, 1000' (W. E. Shull). 1 ♀, Lenore, Ida., 7 May 1938, 1000. (W. W. Shull, E. Ritzheimer).

Irbisia fuscipubescens Knight.
Bul. Brook. Ent. Soc., 36:76, 1941.
Paratypes, 1 ♂, 1 ♀; Tampico, Wash., 10 May 1925 (E. W. Davis).

Irbisia elongate Knight.
Bul. Brook. Ent. Soc., 36:77, 1941.
Paratypes, 1 ♂, 1 ♀; Wen. Mts., Wn., 9 July 1930 (F. P. Dean).

Irbisia nigripes Knight.
Canadian Ent., 57:94, 1925.
Autotype, Rosevere Creek, Raft River Mts., Utah, June 1928 (D Elden Beck).

Pinalitus brevirostris Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):187. 1968.
Paratypes, 1 ♂; Trinidad, Colo., Stonewall, 8500', 7 Aug. 1925 (H. H. Knight). 1 ♀; Trinidad, Colo., Stonewall 8500', 8 Aug. 1925 (H. H. Knight).

Pinalitus rubrotinctus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):189, 1968.
Paratype, 1 ♀; Mt. Lemon, Ariz., Santa Cat. Mts., July 26, 1917, 9000′ (H. H. Knight).

Dichrooscytus flavescens Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):196, 1968.
Paratypes, 2 ♀; Newcastel, Wyo., 19 Ang. 1927 (H. H. Knight). 1 ♂; Grand Can., Ariz., 6 Sept. 1931 (H. H. Knight); 1 ♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight).

Dichrooscytus rufivenosus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):196, 1968.
Paratypes, 1♂. 1 ♀; Pagosa Sprs., Colo., 12 Aug. 1925 (H. H. Knight).

Dichrooscytus ruberellus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):199, 1968.
Paratypes, 1 ♂, 1 ♀; Pingree Pk:. Colo., 22 Aug. 1925 (H. H. Knight).

Phytocoris flavellus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):234, 1968.
Paratypes. 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight, and J. M. Merino).

Phytocoris albidosquams Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):232, 1968.
Paratype, 1 ♂; Nevada Test Site, Nys Co., Nev. (D E. Beck).

Phytocoris juniperanus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3)238, 1968.
Paratype, 1 ♂; Nevada Test Site. Nye Co., Nev. (H. H. Knight and J. M. Merino). On *Juniperus osteosperma*.

Phytocoris subcinctus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):254, 1968.
Paratype. 1 ♂; Richfield, Utah, 15 Aug. 1929 (E. W. Davis), Light trap.

Phytocoris becki Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):214, 1968.
Paratypes, 5 ♂♂, 3 ♀♀; Nevada Test Site. Nye Co., Nev. (D E. Beck, H. H. Knight, and J. M. Merino). Taken on *Ephedra nevadensis*).

Phytocoris tanneri Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):257, 1968.
Paratype, 1 ♂; Richfield, Utah, 15 July 1929 (E. W. Davis). Taken at light trap.

Phytocorois rostratus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):253, 1968.
Paratype. 1 ♂; Nevada Test Site. Nye Co., Nev. H. H. Knight, D E. Beck, and J. M. Merino). Swept from *Chrysothamnus nauseosus.*

Phytocoris tricintus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):256. 1968.
Paratype. 1 ♀; Tucson, Ariz., 12 May 1929 (E. D. Ball).

Phytocoris merinoi Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):227. 1968.
Paratypes. 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (D E. Beck, H. H. Knight and J. M. Merino). Taken on *Grayia spinosa*.

Phytocorius breviatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):226. 1968.
Paratypes. 1 ♂, 3 ♀ ♀; Nevada Test Site, Nye Co., Nev. (J. M. Merino). Taken at black light.

Phytocoris deserticola Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):251. 1968.
Paratype. 1 ♀; Nevada Test Site, Nye Co., Nev. (H. H. Knight).

Phytocoris nigrolineatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):224, 1968.
Paratype, 1 ♂; Nevada Test Site, Nye Co., Nev. (H. H. Knight and J. Merino). Taken on *Solazaria mexicana*.

Phytocoris reticulatus Knight.
Brigham Young Univ. Sci. Bul., Biol. Ser., 9(3):217. 1968.
Paratypes. 1 ♂, 1 ♀; Nevada Test Site, Nye Co., Nev. (Taken from can pit-trap).

Sittocapsus franseriae Knight.
Entomological News, 53:156, 1942.
Paratype, Mohawk, Ariz., April 6, 1927 (Loyd L. Stitt).

Bolteria juniperi Knight.
Brigham Young Univer. Sci. Bul., Biol. Ser., 9(3):202, 1968.
Paratypes, 1 ♂; Nevada Test Site, Nye Co., Nev., 1 ♀; Scipio, Utah, 29 June 1965 (H. H. Knight).

FAMILY SALDIDAE

Saldula varionis Drake and Hottes.
Great Basin Nat., 10(1-4):57, 1950.
Paratypes, 7, 5 from Escalante Desert, Kane Co., Utah (D Elden Beck); 1 from Gateway, Colo., Sept.-Oct. 1949 (F. C. Hottes and C. Drake).

ORDER DIPTERA

FAMILY TIPULIDAE

Erioptera maria Alexander.
Amer. Midl. Nat., 39:20, 1948.
19 paratypes; Puffers Lake, Beaver Canyon, Utah; 20 July 1936 (D. Elmo Hardy).

Tipula edmundsi Alexander.
Amer. Midl Nat., 39:75, 1948.

1 paratype; Logan Canyon, Utah Experimental Station; 22 May 1938 (D. Elmo Hardy).

FAMILY BIBIONIDAE

Bibio knowltoni var. paltidus Hardy.
Utah Acad. Sci., Arts and Letters, 14:203, 1937.
Holotype ♂ - Provo Environs. Utah; 8 May 1937 (D. Elmo Hardy).
Allotype ♀ - Provo Environs. Utah; 8 May 1937 (D. Elmo Hardy).
Paratype ♂ and ♀ - Provo Environs. Utah Co., Utah (Lowell Miller).

Bibio lobata Hardy.
Utah Acad. Sci., Arts and Letters, 14:203. 1937.
Paratype ♀ - Sierra Co., California; W. M. Wheeler Collection.

Bibio painteri James.
Amer. Mus. Noviates 832:2. 1936.
2 paratypes; Manhattan. Kansas; 17 April 1934 C. W. Sabrosky).

Bibio *albipennis beameri* Hardy.
Kans. Univ. Sci. Bul., 30:451, 1945.
8 paratypes; Douglas Co., Kansas; 5 November 1931 (R. H. Beamer).

Plecia americana Hardy.
Kans. Ent. Soc. Jour., 13:15. 1940.
1 paratype; Pensacola. Florida; 30 April 1888 (A. S. Stevens).

Plecia nearetic Hardy.
Kans. Ent. Soc. Jour., 13:20, 1940.
1 paratype ♂ - Morgan City, Louisiana; 17 April 1938 (John Standish).

Bibo melanopilosus var. bisepta Hardy.
Utah Acad. Sci., Arts and Letters. 14:204, figs. 7, 8, 9, 10. 1937.
Holotype, allotype, and 44 paratypes; Provo Environs (Brigham Young University Campus), Utah, 12 May 1936 (D. E. Hardy).

Bibio lucens Hardy.
Utah Acad. Sci., Arts and Letters, 14:203-204, 1937.
3 paratypes; 1 - Hennepin Co., Minn., Oak Grove; 13 May 1933 (A. A. Nichol). 1 - Mer Blue, Ont.; 28 May 1927 (G. S. Walley). 1 - Miners Bay, Ont.; 26 May 1929 (G. S. Walley).

Bibio knowltoni Hardy.
Utah Acad. Sci., Arts and Letters, 14:202-203, figs. 5 and 6. 1937.
Allotype ♀; Sandy, Utah; 5 May 1931 (G. F. Knowlton) (*On Sophia sophia*).
Holotype ♂; Granger. Utah; 29 April 1931 (G. F. Knowlton) (*On Lepidium*).
Paratype ♂; Sunset. Utah; 5 May 1931 (G. F. Knowlton) (*On Erodium cleutarium*).

Bibio sericata Hardy.
Utah Acad. Sci., Arts and Letters. 14:207. 1937.
14 paratypes: 6 - Sunrise, ele. 6318 ft. Mt. Rainier, Washington; 13 August 1931 (J. Wilcox). 8 - Headley, B.C.; 29 August 1923 (C. B. Garrett).

Bibio mickeli Hardy.
Utah Acad. Sci., Arts and Letters. 14:205, figs. 11. 12. 1937.
47 paratypes; 27 - Prontenac, Minn.; 29 May 1930 (C. E. Mickel). 18 - Goodhue Co., Minn.; 29 May 1930 (Carl T. Schmidt). 1 - Minneapolis, Minn., Mississippi River near "U"; 18 May 1922 (Wm. E. Hoffmann). 1 - Ecology Collection; Hennepin Co., Minn.; basswood-maple ass'n; 27 May 1922 (Wm. E. Hoffmann).

Bibio rufalipes Hardy.
Utah Acad. Sci., Arts and Letters, 14:207, 1937.
2 paratypes - Waco, Texas (Belfrage) Collection of C. V. Riley.

Bibio nigrifemoratus Hardy.
Utah Acad. Sci., Arts and Letters, 14:206, 1937.
6 paratypes; 2 - Monte, B.C.; 13 May 1936 (J. K. Jacob). 1 - Rochchester, Washington; 30 March 1932 (Wm. W. Baker). 2 - Mecham, Oregon; Ele. 3680 ft.; 8 May 1927 (H. A. Schullen). 1 - Kiger's Island, Oregon; 12 April 1930 (J. Wilcox).

Bibio utahensis Hardy.
Utah Acad. Sci., Arts and Letters, 14:208-209, 1937.
Holotype and 33 paratypes.
Holotype and 16 paratypes - Provo Environs, Utah Co., Utah (Harry Thomas). 5 - South Fork, Provo Canyon, Utah; 8 May 1937 (D. E. and Agnes Hardy). 1 - Utah Lake, East Side, Utah Co., Utah. 3 - Provo Environs, Utah; 10 May 1937 (M. I. Killpack). 1 - Provo, Utah (A. Sutherland). 6 - Provo, Utah (D. E. Hardy). 1 - Aweme, Man., Canada; 30 May 1923 (R. M. White).

Bibio signatus Hardy.
Utah Acad. Sci., Arts and Letters, 14:208 .1937.
Holotype ♂ - Spanish Fork, Utah; 29 April 1936 (D. E. Hardy).

Bibio velcida Hardy.
Utah Acar. Sci., Arts and Letters, 14:209, 1937.
4 ♂ paratypes; 3 - Low Bush, Ontario, Lake Abitibi; 12 June 1925 (N. K. Bigelow). 1 - Fredricton, New Brunswick; 30 May 1931 (R. P. Gorham).

Philia oklahomensis Hardy.
Utah Acad. Sci., Arts and Letters, 14:211, figs. 19, 20, 21, 1937.
11 paratypes; 1 - Locust Grove, Oklahoma; 5 May 1934 (E. E. Ivy) (genitalia dissected). 2 - Paris, Texas; 9 April 1904 (C. T. Brues). 3 - College Station, Texas; 27, 30 March 1932 (H. J. Reinhard) (4642). 3 - Victoria, Texas; 13 March 1908 (in

Spanish Moss) (J. D. Mitchell). 1 - Dallas, Texas; 25 March 1906 (on *salix*) (W. D. Pierce).

Philia arizonaensis Hardy.
Utah Acad. Sci., Arts and Letters, 14:209, 210, figs. 13, 14, 1937.
3 paratypes; Huachuca Mt., Arizona (Brooklyn Museum Coll. 1929, Catalog No. 162 (2) and 163).

Phila breviceps var. atelestes Hardy.
Utah Acad. Sci., Arts and Letters, 14:210, 1937.
51 paratypes; Meach Lake, Quebec; 21 June 1916.

Philia stigmaterus var. nigra Hardy.
Utah Acad. Sci., Arts and Letters. 14:212. 1937.
14 paratypes; 3 - Plummer, Minn.; 10 and 12 September 1931 (Donald Denning). 5 - Polk Co., Minn.; 5 September 1936 (D. G. Denning). Kittson Co., Minn.; 20 June 1936 (D. G. Denning). 1 - Lancaster, Minn., 26 August 7936 (D. G. Denning).

Philia jamesi Hardy.
Utah Acad Sci.. Arts and Letters, 14:210, 211, figs. 15, 16, 17, 18. 1937.
31 paratypes; 4 - Pingree Park, Colorado; 19 August 1935 (M. and H. James). 1 - Pingree Park, Colorado; 15 August 1934 (A. E. Pritchard). 11 - Pingree Park. Colorado; 14 August 1934 (C. W. Sabrosky). 6 - Masonville, Colorado, 5 and 6 September 1934. 9 - Marshall Pass, Colorado; 16 September 1917, Cornell University Expedition, ele. 10,250 ft. (R. C. Shannon).

FAMILY STRATIOMYIDAE

Ptilocera bergi James
Proc. U. S. Nat'l. Mus., Vol. 98. No. 3228:202. 1948.
5 ♀♀; Solomon Islands, Guadalcanal; 1944 (D E. Beck collection #419. 325, 367. 420, 587. 381). 1 ♀ - Solomon Islands. Guadalcanal; 1944 (Ernest Reimschiissel). 3 ♂♂ - Solomon Islands, Guadalcanal; 1944 (D E. Beck collection #587. 367. 362).

FAMILY TABANIDAE

Chrysops dilatus Rowe and Knowlton.
Ohio Jour. Sci., 36:256, 1936.
1 paratype; St. George, Utah. #28 (head missing).

FAMILY THEREVIDAE

Zionea tanneri Hardy.
Ent. Soc. Amer. Ann., 31:144, 1938.
Genotype-Holotype; Zion Nat'l. Park, Utah (Vasco M. Tanner).

FAMILY ASILIDAE

Mallophora (Mallophorina) pallida Johnson.
Great Basin Nat., 18:41, 1958.
Holotype, Allotype and 12 paratypes; Hollotype, Allotype and 1 paratype - Little Granite Mts., Dugway Pr. Grounds. Tooele Co., Utah; 21 August 1955 (D. E. Johnson). 5 paratypes - same except 19 August 1955. 1 paratype - same except 12 August 1955. 1 paratype - S.E. end of Cedar Mts., Tooele Co., Utah; 28 August 1955 (D. E. Johnson). 2 paratypes - same except 7 August 1957. 1 paratype - 9 miles east of Delta, Millard Co., Utah; 19 August 1957 (D. E. Johnson). 1 paratype - Cane Spring, Cedar Mts., Dugway Pr. Grounds. Tooele Co., Utah; 10 August 1955. (D. E. Johnson).

Erax tanneri Bromley.
N.Y. Ent. Soc. Jour., 44:105, 1936.
Holotype - Buena Vista, Colo., ele. 7,800 ft.; August 1932 (C. Lynn Hayward).

Erax knowltoni Bromley.
Utah Acad. Sci., Arts and Letters, 14:104 ,1937.
Paratype; Milford, Utah; June.

Cyrtopogon albifacies Johnson.
Great Basin Nat., 3(1):1, 1942.
Holotype, Allotype and 1 paratype; Holotype - Glacier Lake, Timpanogos, Utah Co., Utah (Vasco M. Tanner). Allotype and paratype - same (E. T. Vest).

Neoitamus hardyi Bromley.
Utah Acad. Sci., Arts and Lettters, 15:61, 1938.
Holotype and 1 paratype; Spanish Fork, Utah (D. Elmo Hardy).

FAMILY BOMBYLIIDAE

Conophorus painteri Priddy.
Kan. Ent. Soc. Jour. 31:12, 1958.
1 paratype; Bear Ears, Elk Ridge, Utah (Vasco M. Tanner).

Poecilanthrax marmoreus Johnson and Johnson.
Great Basin Nat., 17(1-2):16, 1957.
4 paratypes; Zion Nat'l. Park, Utah (Vasco M. Tanner).

Poecilanthrax varius Painter and Hall.
Kans. Agr. Expt. Sta. Tech. Bul., 106:114, 1960.
3 paratypes; 1 - North Fork, Provo Canyon, Utah (D. Elmo Hardy); 2 - Spanish Fork, Utah (D. Elmo Hardy).

Poecilanthrax tanbarkensis Painter and Hall.
Kans. Agr. Expt. Sta. Tech. Bul., 106(2):109-110, 1960.
5 paratypes; 3 - Tanbark Flat, L.A. Co., California; 2 - 12, 14, July, 1956 (J. C. Hall). 1 - Glendale, L.A. Co., California; 29 July, 1956 (E. I. Schlinger).

Exoprosopa arenicola Johnson and Johnson.
Great Basin Nat., 18(3-4):71, 1958.
4 paratypes; 2 - Little Granite Mt., Tooele, Co., Utah, 24 August 1956 (D. E. Johnson). 1 - Little Granite Mt., Dugway Proving Grounds, Tooele Co., Utah, 12 August 1956 (D. E. Johnson). 1 - S.E. end of Cedar Mts., Tooele Co., Utah, 21 August 1956 (D. E. Johnson).

Exoprosopa utahensis Johnson and Johnson.
Great Basin Nat., 18(3-4):81, 1958.
1 paratype, Antelope Springs, Millard Co., Utah, 10 August 1943 (D. E. Johnson).

Exprosopa sharonae Johnson and Johnson.
Great Basin Nat., 18(3-4):78, 1958.
4 paratypes; 2 - Little Granite Mt., Tooele Co., Utah, 16 August 1958 (D. E. Johnson). 2 - Little Granite Mt., Dugway Proving Grounds, Tooele Co., Utah, 1 September 1955 (D. E. Johnson) Field #39.

Poecilanthrax marginatus Johnson and Johnson.
Great Basin Nat., 17(1-2):14, 1957.
Holotype and Allotype. Johnson's Pass, Tooele Co., Utah, 4 September 1955 (D. E. Johnson).

Poecilanthrax ingens Johnson and Johnson.
Great Basin Nat., 17(1-2):13, 1957.
Holotype and Allotype. Ramsey Canyon, Huachuca Mts., Cochise Co., Arizona, 5 September -955 (F. G. Werner and and G. D. Butler).

Poecilanthrax sackenii monticola Johnson and Johnson.
Great Basin Nat., 17(1-2):23, 1957.
Holotype - Aspen Grove, Utah Co., Utah, 23 July 1955 (D. E. Johnson.
Allotype - Emerald Lake, Mt. Timpanogos, Utah Co., Utah, 4 August 1955 (D. E. Johnson).

Poecilanthraax robusta Johnson and Johnson.
Great Basin Nat., 17(1-2):20, 1957.
Holotype and Allotype. Walker's Pass, California, 29 September 1945 (D. E. Johnson).

Poecilanthrax fasciata Johnson and Johnson.
Great Basin Nat., 17(1-2):11, 1957.
Holotype - Crowley, Colorado, 2 September 1939 (M. T. James).

Poecilanthrax butleri Johnson and Johnson.
Great Basin Nat., 17(1-2):11, 1957.
Holotype - Tucson, Arizona, 15 October 1955 (F. G. Werner) *Baccharis saraothroides*).
Allotype - Tucson Arizona, 14 October 1955 (G. D. Butler) *Baccharis*.

Exoprospa sharonae Johnson and Johnson.
Great Basin Nat. (1958), 18:78.

Holotype - West Side Little Granite Mt., Tooele Co., Utah, 3 September 1955 (D. E. Johnson).
Allotype - S.E. end of Cedar Mts., Tooele Co., Utah, 3 September 1955 (Sharon Johnson).

Exoprosopa arenicola Johnson and Johnson.
Great Basin Nat., 18(3-4):71, 1958.
Holotype and Allotype - Westside Little Granite Mrs., Tooele Co., Utah, 27 July 1955 (D. E. Johnson).

Exoprosopa utahensis Johnson and Johnson.
Great Basin Nat., 18(3-4):81, 1958.
Holotype - Antelope Springs, Millard Co., Utah, 10 August 1943 (D. E. Johnson).
Allotype - S.E. end of Cedar Mts., Tooele Co., Utah, 28 August 1955 (D. E. Johnson).

Exoprosopa abdominalis Johnson and Johnson.
Great Basin Nat., 19(1), 10, 1959.
Holotype and Allotype - Weldon, Kern Co., California; 5 August 1945 (D. E. Johnson).

Exoprosopa butleri Johnson and Johnson.
Great Basin Nat., 18(3-4):74, 1958.
Holotype - 4 miles East Apache Junction, Arizona; 15 May 1954 (G. D. Butler).
Allotype - Sycamore Canyon, Atascosa Mts., Arizona, 22 May 1955 G. Butler) (*Senecio longilobus*).

Oestranthrax farinous Johnson and Maughan.
Great Basin Nat., 13:18, 1953.
Holotype and 6 paratypes; Delta, Utah., 5 July (D. E. Johnson).
Allotype and 1 paratype; Delta, Utah; 5 July 1943 (D. E. Johnson).
2 paratypes - Delta, Utah., 4 July (D. E. Johnson).

Conophorus sackenii Johnson and Maughan.
Great Basin Nat., 13:22, 1953.
Holotype, allotype and 4 paratypes; Herlong, California, 14 May 1944 (D. E. Johnson).

Exepacmus johnsoni Copuillett.
Amer. Ent. Soc. Trans., 21:101, 1894.
1 Androtype ♂. Johnson and Johnson, Inyokern, California, 28 April 1945 (D. E. Johnson).

Lordotus lutcelus Hall.
Calif. Univ. Pubs. Ent., 10:26, 1954.
2 paratypes; Walkers Pass, California, 16 September 1945 (D. E. Johnson).

Lordotus miscellus melanosus Johnson and Johnson.
Great Basin Nat., 19:24, 1959.
Holotype, Allotype and 9 paratypes; Holotype, Allotype - Little Granite Mt., Tooele Co., Utah; 14 September 1957 (D. E. Johnson). 3 paratypes - same except 11 September 1956. 3 -

paratypes - same except 7 September 1956. 2 - Dog Area, Dugway Pr. Grounds, Tooele Co., Utah, 12 September 1955 (D. E. Johnson) Field #44. 1 - same except 31 August 1955 Field #38.

Lordotus lutescens Johnson and Johnson.
Great Basin Nat., 19(1):15. 1959.
6 paratypes; Las Cruces. New Mexico; 25 April 1954 (R. H. Beamer).

Lordotus cinqulatus lineatus Johnson and Johnson.
Great Basin Nat., 19(1):22. 1959.
Holotype, Allotype and 2 paratypes; Ten miles E. San Quintin, Mexico. Baja California; 10 September 1955 (Paul H. Arnaud).

Lordotus perplexus Johnson and Johnson.
Great Basin Nat., 19(1):16, 1959.
Holotype and Allotype; Rillite, Arizona; 20 March 1934 (A. J. Basinger).

Lordotus apicula Coquillett.
Ent. Amer., 3:116, 1887.
Homotype and Plesiotype; Skull Valley, Tooele Co., Utah; 31 May 1956 (D. E. Johnson). One Pleisotype - Skull Valley, Tooele Co., Utah; 9 June 1957 (D. E. Johnson).

Lordotus abdominalis Johnson and Johnson.
Great Basin Nat., 19(1):10.
Holotype - Tucson, Arizona; 24 April 1954 (F. G. Warner). Allotype - West of Standfield. Arizona; 11 April 1955 (Butler and Werner).

Lordotus arizonensis Johnson and Johnson.
Great Basin Nat., 19(1):19, 1959.
Holotype - Sabino Canyon, Santa Catalina Mts., Arizona; 17 October 1955 (G. D. Butler).

Lordotus cingulatus Johnson and Johnson.
Great Basin Nat., 19(1):21, 1959.
5 paratypes; 17 miles north of Wolf Hole, Mohave Co., Arizona; 9 September 1958.

Lordotus sororculus nigriventris Johnson and Johnson.
Great Basin Nat., 19(1):17. 1959.
Holotype. Allotype, and 8 paratypes; Holotype, Allotype and 1 paratype - Skull Valley, Tooele Co., Utah; 13 May 1956 (D. E. Johnson). 1 paratype - same except 3 1May 1956. 1 paratype - same except 18 May 1958. 2 paratypes - same except 2 June 1957. 1 paratype - Dugway Mts., Juab Co., Utah; 25 May 1958 (D. E. Johnson). 2 paratypes - Wig Mts., Dugway Pr. Grounds. Tooele Co., Utah; 23 April 1956 (D. E. Johnson).

Poecilanthrax johnsonorum Painter and Hall.
Kans. Agr. Expt. Sta. Tech. Bul., 106:69. 1960.

Holotype and Allotype:; Little Granite Mt., Tooele Co., Utah; 14 September 1957 (D. E. Johnson).

Poecilanthrax hyalinipennis Painter and Hall.
Kans. Agr. Expt. Sta. Tech. Bul., 106:64, 1960.
4 paratypes. 3 - Little Granite Mt., Tooele Co., Utah; 14 September 1957. 1 - Little Granite Mt., Dugway Pr. Grounds, Tooele Co., Utah; 15 September 1955 (D. E. Johnson) Field #45.

Poecilanthrax apache Painter and Hall.
Kans. Agr. Expt. Sta. Tech. Bul., 106:31, 1960.
2 paratypes; Tucson, Arizona; 15 October 1955 (F. G. Werner) (*Baccharis sarothroides*).

Poecilanthrax painteri Maughan.
Kans. Ent. Soc. Jour., 8:56-57, 1935.
Allotype and 3 paratypes; Allotype and 1 paratype - Blacksmith Fork Canyon, Cache Co., Utah, 20 June 1944 (D. E. Johnson; 2 paratypes - Lava Hot Springs, Idaho, 27 June 1948 (D. E. Johnson).

Poecilanthrax alpha zionensis Johnson and Johnson.
Great Basin Nat., 17(1-2):6, 1957.
Holotype - Zion National Park, Utah, 8 July 1932 (D. E. Johnson).

Lordotus cingulatus rufotibialis Johnson and Johnson.
Great Basin Nat., 19:23, 1959.
Holotype and Allotype; Phoenix, Arizona, 29 September 1940 (Parker).

Conophorus hiltoni Priddy.
Kans. Ent. Soc. Jour., 31:24, 1958.
Holotype, Allotype and 2 paratypes; Herlong, California, 14 May 1944 (D. E. Johnson).

Conophorus collini Priddy.
Kans. Ent. Soc. Jour., 31:31, 1958.
1 paratype; Oceano, S. Luis Obispo Co., California, 24 April 1951 (R. M. Bohart).

Conophorus painteri Priddy.
Kans. Ent. Soc. Jour., 31:12, 1958.
Holotype, Allotype and4 paratypes; American Fork Canyon, Utah, 4 July 1953 (D. E. Johnson); 1 paratype - Aspen Grove, Utah Co., Utah, 19 July (D. E. Johnson).

Amphicosmus arizonensis Johnson and Johnson.
Great Basin Nat., 19:67, 1960.
Holotype and Allotype; Tucson Mts., Arizona; 16 August 1955 (G. D. Butler).

Dicranoclista fasciata Johnson and Johnson.
Great Basin Nat., 19:71, 1960.
Holotype; Cedar Creek, Arizona; 15 miles West of Fort Apache,

21 June 1957 (G. Butler and F. Werner). Allotype; Provo, Utah Co., Utah, July 1933 (D. E. Johnson).

Villa utahensis Maughan.
  Kans. Ent. Soc. Jour., 8:51, 1935.
  2 paratypes; Provo, Utah; 29 April 1934 (D. E. Johnson).
  1 metatype; Provo environs, Utah (D. E. Johnson).

FAMILY DOLICHOPODIDAE

Dolichopus indianus Harmston and Knowlton.
  Amer. Midl. Nat., 36:672, 1946.
  1 paratype; Indianapolis, Indiana; 7 March 1943 (F. C. Harmston).
  1 paratype; Indianapolis, Indiana; 7 March 1943 (F. C. Harmston).

Medeterus arnaudi Harmston.
  Great Basin Nat., 11(1-2):12, 1951.
  ♂ paratype; Redwood City, California, San Mateo Co.; 4 June 1946 (Paul H. Arnaud).

Aphrosylus wirthi Harmston.
  Great Basin Nat., 11(1-2):13, 1951.
  1 paratype; Moss Beach, San Mateo Co., California; 21 March 1948 (W. W. Wirth) (Intertidal rocks).

FAMILY PIPUNCULIDAE

Chalarus latifrons Hardy.
  Kans. Univ. Sci. Bul., 29:33, 1943.
  6 paratypes; 3 - Austin, Nevada; 12 August 1940 (R. H. Beamer, D. E. Hardy). 1 - Cloudcroft, New Mexico; 27 June 1940 (R. H. Beamer); 1 - Ruidoso, New Mexico; 26 June 1940 (R. H. Beamer). 1 - Pacific, California; 9 August 1940 (D. E. Hardy).

Tomosvaryella tumida Hardy.
  Kans. Ent. Soc. Jour., 13:112, 1940.
  2 paratypes; Belle Glade, Florida; 18 July 1939 (R. H. Beamer).

Tomosvaryella xerophila Hardy.
  Kans. Univ. Sci. Bul., 29:188, 1943.
  2 paratypes; 1 - Cuervo, New Mexico; 23 June 1940 (L. C. Kuitert). 1 - Rustler's Peak, Chiricahua Mts., Arizona; 5 July 1940 (D. Elmo Hardy).

Tomosvaryella tumida Hardy.
  Kans. Ent. Soc. Jour., 13:112, 1940.
  1paratype; Belle Glade, Florida; 18 July 1939 (R. H. Beamer).

Tomosvaryella lepidipes Hardy.
  Kans. Univ. Sci. Bul. 29:166, 1943.
  4 paratypes; 2 - Garnett, Kansas; 22 September 1940 (D. Elmo Hardy). 1 - Maybell, Colorado; 18 August 1940 (R. H.

Beamer). 1 - Yosemite National Park, California; 1 August 1940 (D. Elmo Hardy).

Tomosvaryella beameri Hardy.
Kans. Ent. Soc. Jour., 13:107, 1940.
1 paratype: Cherokee Co., Kansas; 30 August 1939 (R. H. Beamer).

Tomosvaryella floridensis Hardy.
Kans. Ent. Soc. Jour., 13:109, 1940.
1 ♂ paratype; Adel, Ga.; 11 August 1939 (J. D. Beamer).

Tomosvaryella wilburi Hardy.
Kans. Ent. Soc. Jour., 12:22, 1939.
1 paratype, 8 metatypes; paratype - Manhattan, Kansas; 13 August 1937 (D. A. Wilbur). 3 metatypes - Tonganoxie, Kansas; 6 May 1939 (D. Elmo Hardy). 4 metaypes - Cherokee Co., Kansas; 30 August 1939 (R. H. Beamer). 1 metatype - Lawrence, Kansas; 22 August 1939 (D. Elmo Hardy).

Tomosvaryella coquilletti coquilletti (Kertesz).

Tomosvaryella proxima Cresson.
Amer. Ent. Soc. Trans., 36:318, 1911.
3 homotypes; Tonganoxie, Kansas; 6 May 1939 (R. H. Beamer) by D. Elmo Hardy.

Tomosvaryella similis Hough.
Boston Soc. Nat. Hist. Proc., 29:84, 1899.
2 homotypes; Garnett, Kansas; 29 August 1939 (R. H. Beamer) compared by D. Elmo Hardy.

Tomosvaryella contorta Hardy.
Kans. Ent. Soc. Jour., 12:18, 1939.
10 metatypes; 1 - Onyx, California; 23 August 1940 (D. Elmo Hardy). 1 - Onyx, California; 23 August 1940 (R. H. Beamer). 1 - Kernville, California; 24 August 1940 (R. H. Beamer). 3 - Tonganoxie, Kansas; 6 May 1939 (D. Elmo Hardy). 2 - Garnett, Kansas; 29 August 1939 (J. D. Beamer).

Tomosvaryella subvirescens Loew.
Berlin Ent. Ztschr., 16:87, 1872.
7 homotypes; 1 - Toganoxie, Kansas; 6 May 1939 (D. Elmo Hardy). 2 - Toganoxie, Kansas; 3 September 1939 (R. H. Beamer). 4 - Douglas Co., Kansas; 23 August 1939 (R. H. Beamer) compared by D. Elmo Hardy).

Tomosvaryella exilidens Hardy.
Kans. Ent. Soc. Bul., 29:162, 1943.
2 paratypes; 1 - Moriarty, New Mexico; 24 June 1940 (E. E. Kenaga). 1 - Sunnyside Canyon, Huachuca Mts., Arizona; 9 July 194- (D. Elmo Hardy).

Tomosvaryella turgida Hardy.
Kans. Ent. Soc. Jour., 13:113, 1940.

2 paratypes; Griffin, Georgia; 12 August 1939 (R. H. Beamer, A. T. Hardy).

Tomosvaryella agnesea Hardy.

Kans. Ent. Soc. Jour., 13:103, 1940.

2 paratypes and 4 metatypes; Paratypes, 1 - Manhattan, Kansas, 15 June 1943 (D. A. Wilbur). 1 - Douglas Co., Kansas; 23 August 1938 (R. H. Beamer). Metatypes, 1 - Glasco, Kansas; 24 August 1940 (E. E. Kenaga). 1 - Arivaca, Arizona; 12 July 1940 (R. H. Beamer). 1 - Kernville, California; 24 July 1940 (R. H. Beamer). 1 - Onyx, California; 23 July 1940 (D. Elmo Hardy).

Tomosvaryella dissimilis Hardy.

Kans. Univ. Sci. Bul., 29:161, 1943.

2 paratypes; 1 ♂ - Chiricahua Mts., Arizona; 4 July 1940 (D. Elmo Hardy). 1 - Bishop, California; 28 July 1940 (L. C. Kuitert).

Tomosvaryella aliena Hardy.

Kans. Ent. Soc. Jour., 20:146-153, 1947.

New name for *propinqua* Hardy.

Kans. Univ. Sci. Bul., 29:169, 1943.

5 paratypes; 1 - Goshen, Utah; 16 August 1940 (R. H. Beamer). 2 - Goshen, Utah; 16 August 1940 (L. C. Kuitert). 1 - Fruita, Colorado; 4 September 1938 (D. Elmo and A. Hardy). 1 - Lone Pine, California; 28 July 1940 (R. H. Beamer).

Tomosvaryella quadradentis Hardy.

Kans. Univ. Sci. Bul., 29:172, 1943.

3 paratypes; 2 - Carson City, Nevada; August 1940 (D. Elmo Hardy). 1 ♂ - Silver Lake, Kansas; 24 August 1940 (L. J. Lipovsky).

Tomosvaryella brevijuncta Hardy.

Kans. Univ. Sci. Bul., 29:155, 1943.

1 paratype; Palm City, California; 19 July 1940 (R. H. Beamer).

Dorylomorpha tridentata Hardy.

Kans. Univ. Sci. Bul., 29:141, 1943.

2 paratypes; 1 - Lake Tahoe, California; 11 August 1940 (R. H. Beamer). 1 - Lake Tahoe, California; 11 August 1940 (D. Elmo Hardy).

Pipunculus nevadensis Hardy.

Kans. Univ. Sci. Bul., 29:106, 1943.

1 paratype; Fallon, Nevada; 12 August 1940 (E. E. Kenaga).

Pipunculus huachueanus Hardy.

Kans. Univ. Sci. Bul., 29:95, 1943.

2 paratypes; 1 - Sunnyside Canyon, Huachuca Mts., Arizona; 9 July 1940. (R. H. Beamer). 1 - Sunnyside Canyon, Huachuca Mts., Arizona; 9 July 1940 (D. Elmo Hardy).

Pipunculus cinctus subtilis Hardy.

Kans. Univ. Sci. Bul., 29:84, 1943.

1 paratype; Pingree Park, Calorado; 11 July 1937 (C. L. Johnston).

Pipunculus kansensis Hardy.
Kans. Ent. Soc. Jour., 13:102, 1940.
2 paratypes; 1 - Tekio, North Dakota; 28 July 1937 (C. L. Johnston). 1 - Douglas Co., Kansas; 25 August 1939 (R. H. Beamer).

Pipunculus albofasciatus Hough.
Boston Soc. Nat. Hist. Proc., 29:85, 1899.
3 homotypes; 2 - Garnett, Kansas; 29 August 1939 (R. H. Beamer). 1 - Clarksville, Tenn.; 15 July 1939 (D. Elma Hardy) compared by D. Elmo Hardy.

Pipunculus cingulatus Loew.
Berlin Ent. Ztschr. (1865), 9:176, 1866.
2 homotypes; Tangonoxie, Kansas; 6 May 1939 (D. Elmo Hardy) compared by D. Elmo Hardy.

FAMILY CHLOROPIDAE

Oscinella hesperia Sabrosky.
Canadian Ent., 72:219, 1940.
4 paratypes; Spanish Fork, Utah Co., Utah (D. Elmo Hardy).

ORDER HYMENOPTERA

FAMILY SCOLIIDAE

Campsomeris solomonis Krombein.
Nova Guinea (Zool.) No. 22:570, 1963.
2 paratypes; Solomon Islands, Guadalcanal; 1944 (Ernest Reimschiissel).

Scolia pulchripennis franclemonti Krombein
Nova Guinea (Zool.) No. 22:636, 1963.
1 paratype; Solomon Islands, Guadalcanal; 1944 (D E. Beck).

INDEX TO VOLUME XXIX

The new genera, species, and varieties in this volume appear in bold type in this index.